The FOUNDRY

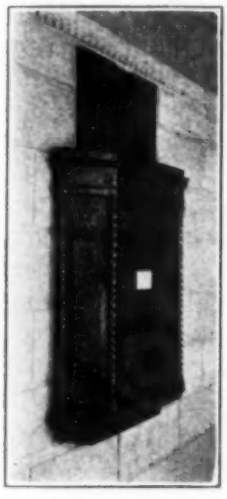
Volume 57
Number 5

Published
Semimonthly

CLEVELAND, OHIO, MARCH 1, 1929

Castings Collect Mail for Uncle Sam's Carriers

WHEN the Continental Congress asked Benjamin Franklin to organize the first American post office system, the residence of a leading citizen usually became the distributing point for mail carried from settlement to settlement by the horseback rider. The post office became the distributing point for news and the center of attraction for the entire population



Artistic Cast Metal Mail Boxes Are Located in the Lobbies of Modern Buildings

Courtesy Cutler Mail Chute Co.

when the mail arrived. In time settlements grew into towns and towns into cities, and at the same time improvements were made in the mail service. The stage coach and the river boat took the place of the horseback rider, and as the iron horse became the major means of transportation, the railway post office came into being. In 1863, under the administration of President Lincoln, the postmaster general introduced the first free delivery system in cities of 50,000 and over. Because this feature eliminated the necessity for each person going to the post office to procure mail, steps were taken to provide receiving boxes throughout the city to facilitate collection of the mail. Since letter boxes must be built of materials which will withstand the corrosive action of the elements, cast iron has been used extensively, and aluminum and other cast metals also are employed. The introduction of the skyscraper has led to the development of the mail chute, with cast metal receivers of artistic design.

Find Where Castings Can Be Sold.

CONTENTS

FEATURE ARTICLES

Page

Produces Alloy Castings To Withstand Severe Service—By Herbert R. Simonds 180

Measure Temperature of Molten Cast Iron—By H. T. Wensel and W. F. Roeser 184

Small Jobbing Shop Transports Materials Easily 188

Melting Steel In the High Frequency Furnace—II—By Heinz Neuhauss 192

Melting Iron in the Cupola—Part XIII—By J. E. Hurst 196

Bill Diagnoses a Leak in a Pipe Casting—By Pat Dwyer 202

Heap Sand Causes Trouble—By H. T. Preston 205

Steel Castings Play New Role 206

Makes Patterns for Roller Chain Sprockets—By H. N. Tuttle 207

Molds Enamel Ware on Continuous Units—By J. B. Nealey .. 210

Monolithic Linings—By H. C. Elliot 212

REGULAR DEPARTMENTS

How and Why in Brass Founding — By Charles Vickers 191

Metal and Melting Problems 195

What Others Are Thinking 213

The Shakeout 214

Trade Trends in Tabloid ... 215

Comings and Goings of Foundrymen 216

What the Foundries Are Doing 220

—□—

PUBLISHED BY THE PENTON PUBLISHING CO., CLEVELAND, O.
BRANCH OFFICES

CHICAGO ..... 1147 Peoples Gas Bldg.
CINCINNATI ..... 209 Edwards Bldg.
NEW YORK ..... 2203-2206 No. 220 Broadway
PITTSBURGH ..... 2148-49 Oliver Bldg.
SAN FRANCISCO ..... 24 California Street
WASHINGTON, D. C. ..... 1653 Pennsylvania Avenue
BIRMINGHAM, ENGLAND ..... Prince's Chambers
LONDON, ENGLAND ..... 416-417 Caxton House, Westminster, S. W. 1
PARIS, FRANCE ..... No. 9 Rue de Londres
BERLIN, GERMANY ..... Wilhelmstrasse 114, Berlin S. W. 48

Cable address, IROTRAPEN, London

SUBSCRIPTION

United States and Mexico ..... $3.00 a year
Canada ..... $4.00 a year
Great Britain and other Foreign Countries ..... £1:0:0 a year
Single copies ..... 25 cents

Copies published three months or more previous to date of current issue, 50 cents each

Member, Audit Bureau of Circulations, Associated Business Papers Inc., National Publishers' Association

The A. B. P. is a nonprofit organization whose members have pledged themselves to a working code of practice in which the interests of the men of American industry, trade and professions are placed first—a code demanding unbiased editorial pages, classified and verified paid subscribers, and honest advertising of dependable products

Copyright 1929 by the Penton Publishing Co.

Produces Alloy Castings

To Withstand

SEVERE SERVICE

By Herbert R. Simonds

THE foundry business ain't what it used to be." Thus did an old time Connecticut melter express his opinion of changing conditions. He was thinking of encroaching processes, stamping, forging, die casting and welding, and was overlooking the possibilities of new alloys and of specialization in the development of the casting industry. Despite undisputed encroachments, the foundry, even the small foundry, is not without bright promise for the future, according to H. A. Cooper, head of a recently developed alloy foundry business in Irvington, N. J.

Fig. 1—Large risers are required

Mr. Cooper in 1922, had the courage to leave an attractive salary job in Philadelphia, and with two associates and modest capital, to start a small foundry under the title of the Wm. J. Sweet Foundry Co. He started this foundry at a time of keen competition and succeeded. Because the underlying principles of his success are those that usually mean success in any enterprise the history of Mr. Cooper's progress is of more than passing interest.

One of his business principles called for experience in and knowledge of the process involved, and as he and his associates had put in many years in making nickel and monel metal castings they decided to specialize in these products. Another principle involved a further specialized practice, that of making castings for a definite purpose or for well defined uses. They accordingly concentrated their early activities on the manufacture of castings for ammonia oxidation plants, for the food and canning industries and for one or two other related fields.

Following out other ideas of policy, they started operating in a small building equipped with crucible pit furnaces. During the first year of activity, 1630 pounds of pure nickel and a fair quantity of monel metal castings were made and sold. Temptations to extend variety of products and materials often are strong with a new company, but the men directing the destiny of the Wm. J. Sweet Foundry Co., resisted most of them and confined their efforts so closely to nickel that it was not long before production of nickel castings had increased tenfold and now exceeds 30,000 pounds a year.

When it became necessary to seek larger quarters, the company decided to build a plant on land which likely would increase in value. In this way reliance for increase in assets would not depend entirely on foundry operations. Accordingly in 1924, a tract of land was purchased on the then deserted Chestnut avenue, Irvington, N. J., a suburb of Newark, in a direction where rapid growth was indicated. The street now is built up on both sides with attractive modern manufacturing plants. The property of Wm. J. Sweet Foundry Co. has more than tripled in value in the four years since its purchase and is an indication of the foresight of the company's officers.

Increased facilities and capacity of the new building made some extension in line of products advisable. Nickel and nickel alloy castings are closely associated with other metals in the food and chemical industries. Many of the so-called stainless steel alloys are admirably suited to the production of acid resisting castings. The Wm. J. Sweet Foundry Co., naturally turned to stainless steel products and to the manufacture of

parts from other similar iron and steel alloys.

At first arrangement was made to use various trademarked alloys in co-operation with the patentees, but gradually as the makers studied the uses to which their various products were put, new alloys were suggested. After carefully co-ordinating the melting and foundry practice with the service demand on the castings, the company has standardized on seven alloys for seven different purposes. These alloys with their typical analyses and physical properties are listed in the accompanying tables. The principal industrial applications for each alloy are shown at the right. Adequate melting equipment was necessary to produce these alloys, and in 1925 the company purchased a three-phase, arc type electric furnace with automatic regulation and full equipment from the Pittsburgh Electric Furnace Corp., Pittsburgh. This augmented the crucible type of furnace previously in use and allowed the company to expand into the acid resisting steel field in the production of castings.

H. A. COOPER, prominently identified with the production of nickel and steel alloy castings was born in Bayonne, N. J. in 1898. He was educated in the public schools and in New York University. His first foundry experience was with the Bayonne Casting Co., which later was changed to the Monel Metal Products Co., and still later merged with the International Nickel Co. He was active in the sales department after the war and then was transferred to the development department. He had opportunity to watch and help in the rapid development of monel metal and pure nickel. In 1922 with an initial investment of approximately $6000, H. A. Cooper, Wm. J. Sweet and C. C. Bruno, rented a small shop in Philadelphia where they started specializing in monel metal and nickel castings. Two years later they moved to the present location in Irvington, a suburb of Newark, N. J. In 1925 they installed electric furnace melting equipment and added various stainless steels to their product.

The relatively small furnace melts a heat of approximately 800 pounds, and its size is admirably suited to the service required. Experience has shown that this equipment will take care of nearly any of the usual acid resisting castings normally used in the food and chemical industries. The small size of the furnace gives it flexibility and ease of control difficult to obtain with a larger unit. Also, as only one alloy at a time is poured with appreciable interval between charges, a larger furnace would mean a greater delay in reaching the last of a series of different alloys which might be scheduled. Work is carefully systematized to reduce the number of changes from one alloy to another in the furnace. Orders are segregated and the work is laid out for melting definite alloys on definite days. Sequence of different alloys as they follow one another has been worked out carefully in co-operation with the metallurgist to minimize the effect of any residue from one alloy on the succeeding charge. After considerable difficulty in connection with this residue effect, the metallurgist has adopted a practice of taking a wash heat of gray iron or steel between alloy heats. This wash heat is not wasted. The metal is used in making flasks and other castings needed in the foundry. Experience has shown that a semisteel wash heat picks up some chromium and nickel from the furnace lining, and the result is an excellent material for flasks. Even after this wash heat, traces of chromium, nickel and silicon are left and these must be taken into account in determining the nature of the succeeding heat. Metal in the electric furnace is melted under a basic slag and magnesium is used in the ladle as a deoxidizing agent for nearly all of the alloys.

Molding practice must be modified to conform to the changing physical properties of the fluid metal. In any alloy casting practice the melting and molding operations must be closely linked.

Sometimes at the Wm. J. Sweet foundry it is necessary to adjust the mixture slightly for certain complicated castings to avoid shrinkage or to increase fluidity for thin sections. Pure nickel is sluggish and must be handled carefully to fill thin sections without freezing. The molding floor for high nickel alloys and for pure nickel is located close to the furnace or melting section. Nearly all the ladles are pre-

Fig. 2—Flasks are built up high to provide a high head and feeders

heated at a special furnace located close to the electric melting furnace. The nickel is superheated and a lime slag is used because it prevents cooling.

Strictly pure nickel castings are almost impossible to obtain. In actual use they have less desirable qualities than castings with 1.00 or 2.00 per cent or more of other elements. Mr. Cooper has had long experience with nickel. In the production of so-called pure nickel castings he has found it advisable to add small amounts of carbon, silicon and manganese.

Nickel casting production of the company involves many unusual and interesting problems. Recently an order for 8000 pounds of pure nickel castings was received from Japan. These were desired for anodes for some special electrolytic process. The specifications called for 99 per cent pure nickel, but Mr. Cooper thought this was impractical. He cabled the customer that 99 per cent nickel castings of the type desired were beyond his capacity. He could guarantee 98 per cent nickel. The Japan firm accepted the 98 per cent guarantee. After some experimenting an alloy of full 98 per cent nickel and otherwise satisfactory for this particular work was developed. The order was filled and delivered.

Recently the company made up a lot of special fittings for use of the Anaconda Copper Co., Butte, Mont., in handling acids. They were made up in accordance with specifications for standard alloy No. 17. Some weeks later a foreman at the Butte plant sent in an order for the same alloy fittings for use in the water system in his residence. He had corrosion difficulty with other fittings.

This particular alloy is used successfully as a marker to designate walks across boulevard pavements.

Table I

Report of Physical Tests

Alloy Steel No. 17 submitted by Wm. J. Sweet Foundry Co., Irvington, Newark, N. J.

Laboratory number	X-35933
Diameter, inches	.501
Area, square inches	0.1971
Diameter after fracture	.383
Fractured area, square inches	0.1152
Yield point, pounds	8,300
Maximum load, pounds	16,600
Yield point, pounds per square inch	42,100
Tensile strength, pounds per square inch	84,200
Per cent elongation in 2 inches	47.0
Per cent reduction of area	41.5

Table II

Nickel and Steel Alloy Castings for Corrosion and Heat Resistance

Alloy number	Maximum endurance temperature	Typical analysis	Tensile strength lb. per sq. in.	Yield point lb. per sq. in.	Elongation in 2 inches	Reduction in area per cent	Brinell No.	Weight per cu. in.	Shrinkage per foot	Recommended for	Remarks
16	1600 Fahr.	Cr — 18.00 C under 0.35 Bal. mostly Fe	75,000	50,000	10.00	15.00	200	0.28	¼ inch	Superheated Steam Nitric Acid Hot Oil	Ideal for valve trim for high pressure, superheated steam. Low expansion coefficient. Oil cracking coil return bend fittings, pump valves, etc. Equipment for production nitric acid. Readily machinable.
17	1700 Fahr.	Cr. — 18.00 Ni — 8.00 C under 0.20 Bal. mostly Fe	84,200	42,100	47.00	42.00	165	0.28	19/64 inch	Acetic Acid Lactic Acid Citric Acid Phosphoric Acid Hydrocyanic Acid Salt Water Mine Water	Best general resisting alloy steel. Also good low-cost heat resisting alloy. Excellent abrasive resisting qualities. Readily machinable. Unaffected by vinegar. Used for pumps, valves, cocks, equipment for food products.
18	1800 Fahr.	Ni — 22.00 Cr — 10.00 C under 0.25 Bal. mostly Fe	79,000	46,500	23.00	24.00	150	0.29	19/64 inch	High sulphur oil Sulphuric Acid Ammonia	Used for cracking coil plugs in oil refineries, thermocouple wells, etc. Also for pickling equipment. Readily machinable.
19	1900 Fahr.	Cr — 28.00 C under 0.50 Bal. mostly Fe	50,000	35,000	2.00	3.00	170	0.28	¼ inch	Mixed nitric-sulphuric acid. Sulphur gases at high temperature. Molten Metals.	High chrome iron containing only trace of nickel. Readily machinable but can be made extremely hard for excellent abrasion resistance. Less load carrying ability of high temperatures.
20	2000 Fahr.	Ni — 36.00 Cr — 18.00 C under 0.50 Bal. mostly Fe	64,000	41,200	7.00	7.80	165	0.29	19/64 inch	Alkalies at high temperature. Molten Lead	Greatest high temperature strength. High load-carrying ability at elevated temperatures. Readily machinable. Suitable for furnace parts, enameling racks, etc.
21	2100 Fahr.	Ni — 65.00 Cr — 15.00 C under 0.50 Bal. mostly Fe	62,000	45,000	4.00	3.00	170	0.29	19/64 inch		Offers great resistance to deformation at elevated temperature. Used for carburizing boxes, pots, retorts, etc.
22	2200 Fahr.	Cr — 28.00 Ni — 10.00 C under 0.50 Bal. mostly Fe	70,000	59,500	3.00	2.00	200	0.28	19/64 inch	Sulphurous acid Ammonium Nitrate	Used primarily for the sulphate pulp mill, for digester fittings, pumps, valves, piping, etc.

It is severe service and calls for a combination of rust resisting and wear resisting properties.

Other uses for acid resisting steels are found in ginger ale and in fruit juice bottling plants, in oil cracking plants and in special cases in chemical manufacturing. No. 18 alloy is used successfully for plugs where absolutely tight joints at high temperature are required. This alloy has a slightly higher coefficient of expansion than carbon steel. When the alloy plug is screwed into a heavy carbon steel fitting it expands to an absolutely tight joint under the action of heat, and then contracts to be easily removed when the temperature drops.

Molding practice in connection with alloys is the same as that in carbon steel foundries. Nearly all the molds are made in green sand, and faced with graphite. Large gates are used, even larger than with carbon steel and many risers are employed to compensate for shrinkage. In addition to these precautions it is frequently necessary to cut brackets at the junction of light and heavy sections.

Heads, gates and brackets are removed with the electric torch. Before this method was used the oxyacetylene cutting torch was tried without success. Special alloy castings are snagged largely with rubber bonded abrasive wheels traveling at about 7000 surface feet per minute.

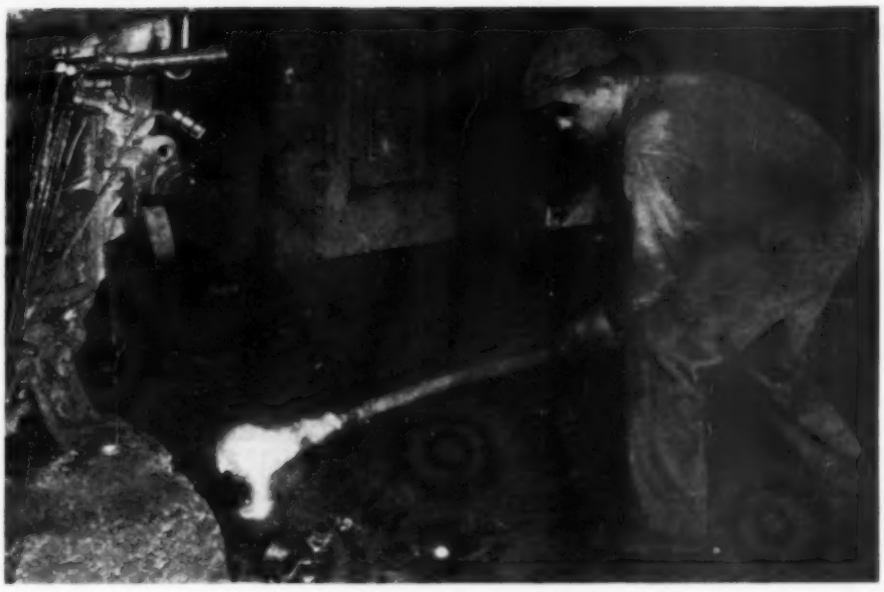


FIG. 4—SMALL TEST BLOCKS ARE POURED AND ANALYSED BEFORE THE HEAT IS TAPPED FROM THE FURNACE

An important feature of the foundry is a laboratory where all the usual analyses are made. Control of the various elements entering into the different alloys is aided greatly by fracture tests and by analyses of test bars. Temperature control is the result of long experience and is governed in actual practice chiefly by the time of melting. Appearance, feel of the metal against a bar and time required to freeze in a test box indicated the temperature to the melter.

FIG. 3—A WIDE VARIETY OF HEATS ARE MELTED IN THE ELECTRIC FURNACE

Fittings for oil cracking equipment are cast in No. 18 alloy. This alloy has proved so successful in resisting the effects of high sulphur content in the oil that the life of certain parts has been two years as against a maximum of three months for the parts which they replaced. High nickel alloys have been easier to produce with small amounts of graphite introduced into the charge. Chromium iron alloys vary greatly in fluidity with variations in chromium content. An 18 per cent chromium alloy is exceedingly sluggish and difficult to pour. If the chromium is raised to 25 or 28 per cent the metal becomes much more fluid at the same temperature and runs easily into small sections.

Machinability of the company's chromium alloys also varies with the chromium content in a manner not ordinarily expected. An 18 per cent chroimum alloy is almost unmachinable until it is double annealed, whereas a 28 per cent chromium alloy is readily machinable although it has some poor physical properties. This acid resisting metal actually is unaffected by a mixture of nitric and sulphuric acids. It is used for fittings for sulphate pulp mills.

Measure Temperature OF *MOLTEN CAST IRON*

By H. T. Wensel and W. F. Roeser

Part I

TEMPERATURE of molten cast iron may be measured by a themocouple, an optical pyrometer, or a radiation pyrometer. Of these three the thermocouple gives perhaps the most satisfactory values but involves the greatest trouble and expense.

Platinum to platinum-rhodium thermocouples, in suitable protecting tubes, can be used up to 1600 degrees Cent. (2900 degrees Fahr.) however. At high temperatures, they deteriorate rapidly and in molten iron any of the protection tubes now available have only a short life. The expense of replacing or recalibrating the couples and the labor and expense of frequently renewing the protection tubes rule out the rare-metal couple as an instrument for general use in molten iron and steel.

There is no upper limit to the range of usefulness of optical or radiation pyrometers. When used upon metals in the open, however, these pyrometers are subject to corrections which may reduce seriously their usefulness, unless these corrections be properly taken into account and carefully made.

Optical and radiation pyrometers usually are calibrated to read correctly when sighted upon objects inside a hollow enclosure of sensibly uniform temperature, such as a furnace with an opening small in comparison with the area of the walls. Under such conditions, usually referred to as black body conditions, the pyrometer receives not only the energy radiated by the object sighted upon, but also energy radiated by other portions of the furnace and reflected by the object.

In such a furnace the lack of energy radiated by a body exactly is compensated in every case by the energy reflected from the walls since bodies which have a low radiating power always have a correspondingly high reflecting power. Under black body conditions the light received by the pyrometer is independent of the radiating characteristics of the materials and depends only upon the temperature.

When sighted upon a surface in the open, a pyrometer receives only the energy radiated by the object itself, and, consequently, always reads low. The ratio of energy radiated by a surface in the open to that radiated by a black body at the same temperature is known as the emissivity of the surface. For example, the emissivity of an unoxidized iron surface is about 0.4 while the value generally accepted for iron oxide (solid) is about 0.9. At 1400 degrees Cent. (2500 degrees Fahr.) this corresponds to a correction of 110 degrees Cent. (200 degrees Fahr.) for iron and 15 degrees Cent. (25 degrees Fahr.) for iron oxide when observed, in the open

Make Investigations

THIS article is abstracted from a paper presented at the Philadelphia convention of the American Foundrymen's association held May 14 to 18. Owing to its length the paper will be published in two sections. H. T. Wensel and W. F. Roeser, authors of the paper, are associate physicist, chief of pyrometry section, and assistant physicist, pyrometry section, bureau of standards, Washington.

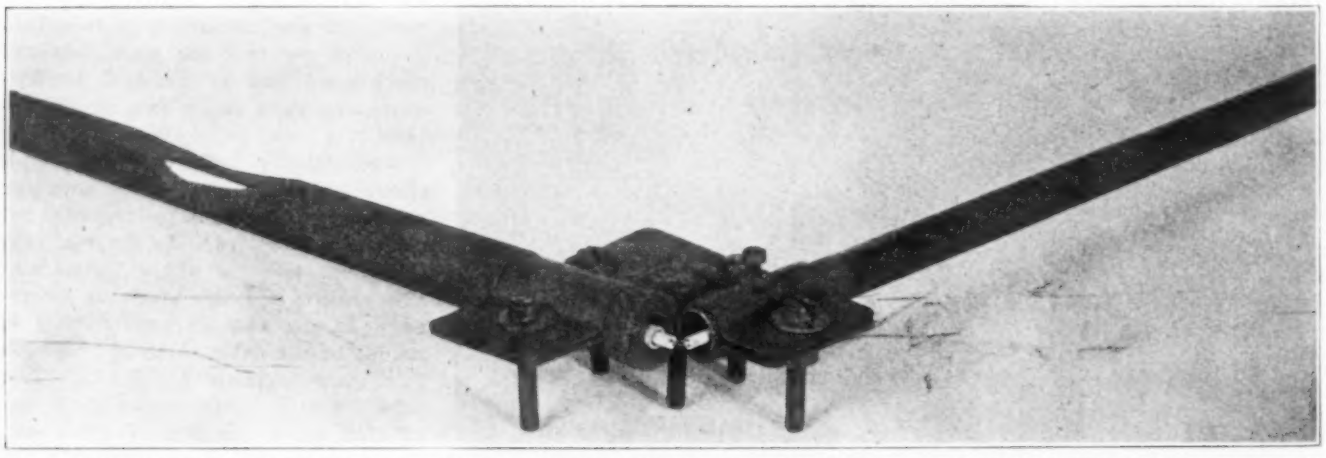


FIG. 1—ARRANGEMENT OF GRAPHITE AND PORCELAIN TUBES IN THE THERMOCOUPLE. A PORTION OF THE GRAPHITE TUBE IS CUT AWAY ON THE LEFT TO SHOW THE PORCELAIN TUBE

with an optical pyrometer. The corresponding corrections in the case of a radiation pyrometer are about four or five times as great as those given above.

It has been the practice to apply the corrections recommended by Burgess, bureau of standards *Technologic Paper* No. 91, to observations taken on iron and steel with an optical pyrometer. Burgess recommends using the value 0.40 for the emissivity of streams of apparently clean iron instead of the value 0.37 for pure iron obtained by him (bureau of standards, *Bulletin* No. 11) under laboratory conditions. He gives the emissivities of liquid and solid iron oxide at 0.53 and 0.92 respectively. Liquid slag is stated to have "a variable emissivity of uncertain limits, depending on composition, but probably ranging between 0.55 and 0.75." Table I contains some of the values for these substances obtained by various investigators.

Determines Emissivity

There is some question as to whether observations made on pure iron and iron oxide under laboratory conditions are applicable to commercial foundry practice. One cannot be sure that the surface being observed is the same as one of those studied in the laboratory until this has been checked under actual foundry conditions. The values given by Burgess were obtained under laboratory conditions, while those of Fry and of Moeller were obtained under service conditions.

Greenwood, Carnegie Scholarship *Memoirs*, XII, 1923 has reported numerous pyrometer readings taken during steel making and iron casting. His temperature measurements, are all relative, however. He determined the emissivity of slag relative to that of iron. Using the value 0.4 for iron, he finds 0.56 as the emissivity of slag.

Recently Wenzl and Morawe, *Stahl und Eisen*, 1927, have obtained results which led them to the conclusion that an optical pyrometer requires a correction of only 10 degrees Cent. to indicate the true temperature of ladles and streams of molten cast iron in commercial work. For obtaining true temperatures in the furnace they used a rare metal thermocouple protected by a quartz tube with an outer tube of carborundum. For measurements in streams, the measuring junction of a platinum to platinum-rhodium couple was sealed into a thin quartz tube by means of a welding torch, forming a thin protective coating to reduce thermal lag.

The carborundum tube was dispensed with here. They also used iron to constantan and iron to nickel couples with apparent success. The former failed at about 1280 degrees Cent. and the latter at about 1250 degrees Cent.

Simultaneous readings were obtained with a thermocouple inserted in the stream or ladle and with optical pyrometers calibrated for black body conditions. All the observations reported were taken below 1380 degrees Cent. and resulted in corrections of about 10 degrees. One observation at 1370 degrees, in which the optical pyrometer read 92 degrees low, was rejected because the observation was taken through a veil of smoke.

Wenzl and Morawe report also measurements made during the pouring of a 19-ton forging ingot. The optical measurements on the pouring stream yielded 1420 degrees Cent. while the true temperature of the ingot just after pouring, was 1495 degrees or 75 degrees higher. They state that "this does not seem to rule out the fact that the correction factor hitherto used (in this case about 120 degrees) applies here because the steel must have experienced a cooling in the long time of pouring." While these authors have shown that the corrections to be applied below 1350 degrees Cent. true temperature are small, their work should not be taken to indicate that the corrections above 1400 degrees Cent. are of the same order of magnitude.

Recently, Herty, *Bulletin*, Carnegie Institute of Technology, 34, 1927, and others working at the bureau of mines measured the true and apparent temperatures on a bath of pig iron by sighting with an optical pyrometer on the free surface and on the bottom of a closed silica tube in a graphite casing immersed in the molten metal. They obtained a smooth correction curve varying from 95 degrees at 1400 degrees Cent. to 120 degrees and 1600 degrees Cent. They apparently made no readings below 1390 degrees Cent. true temperature.

Results of Herty and of Wenzl and Morawe are not necessarily contradictory, even though Herty found corrections more than ten times as great as those of the other two. The temperature ranges in which these observers worked overlap at only one point, namely, the observation of Wenzl and Morawe on the 19-ton

Table I

Values Obtained by Investigators

Emissivities for $\lambda = 0.65$ (Red Light)

Substance	Temperature Deg. C.	Emissivity		Observer	Date
Pure iron	800	0.63 solid			
Pure iron	1000	0.54 solid		Bidwell[3]	1913
Pure iron	1200	0.43 solid			
Pure iron	1200	0.23 liquid	(Undercooled!)		
Pure iron	1400	0.38 solid			
Pure iron	1400	0.31 liquid	(Undercooled!)		
Pure iron	1800	0.48 liquid			
Pure iron	700	0.27 solid			
Pure iron	1200	0.29 solid		Bidwell[4]	1914
Pure iron	1300	0.29 liquid	(Undercooled!)		
Pure iron	1500	0.35 liquid	(Undercooled!)		
Pure iron	1800	0.53 liquid			
Pure iron	1050	0.379 solid			
Pure iron	1530	0.360 solid		Burgess[2]	1915
Pure iron	1535	0.365 liquid			
Commercial iron and steel	1150-1700	0.45 liquid		Fry[5]	1924
Commercial iron and steel	750-1600	0.435		Moeller, Miething and Smick[6]	1925
Iron oxide	1200	0.63 solid		Burgess[2]	1915
Iron oxide	1610	0.53 liquid			
Iron oxide	800	0.98 solid			
Iron oxide	1000	0.95 solid		Burgess and	
Iron oxide	1200	0.92 solid		Foote[7]	1915-16
Oxide on ordinary iron and steel	750-1500	0.6 solid			
Oxide on stainless steels	700-1400	0.7 solid		Fry[5]	1924
Iron oxide	1110-1600	0.9 liquid			
Iron oxide	840-1200	0.8 solid		Moeller et al.[6]	1925
Slags	.....	0.55 to 0.75		Burgess[2]	1917
Slags	.....	0.9		Fry[5]	1924

[2]Burgess, Bull. Bureau of Standards, 11, p. 591; 1915.
[3]Bidwell, Phys. Rev. (2), 1, p. 482; 1913.
[4]Bidwell, Phys. Rev. (2), 3, p. 439; 1914.
[5]Fry, Stahl and Eisen, 44, p. 1783; 1924.
[6]Moeller, Miething and Smick, Z. f. techn. Phys., 6, p. 644; 1925.
[7]Burgess and Foote, Bull. Bureau of Standards, 12, p. 83; 1915-1916.

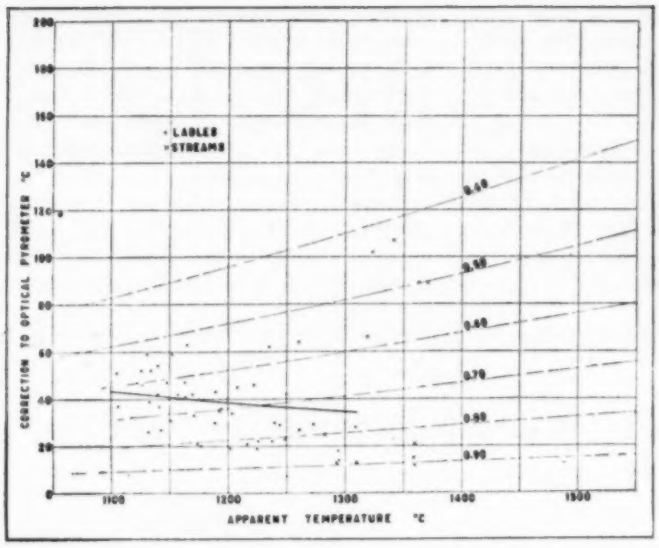


Fig. 2—Results of the Tests at Birmingham. Broken Lines Represent the Corrections Corresponding to the Indicated Emissivity Values for Wavelength 0.65 Micron. The Heavy Line Is Intended to Represent the Observations on the Ladles

forging ingot where the correction was found to be in agreement with Herty's results.

While it is, of course, desirable for some purposes to know the true temperature of iron and steel, the apparent temperature (uncorrected optical reading) would serve equally well for the purpose of temperature control if, at a given temperature, the optical reading were always low by the same amount. However, it has been the experience in some foundries that the optical pyrometer readings in the neighborhood of 1300 degrees Cent. are not reliable even for temperature control. In one large pipe foundry, for example, it has been found that no trouble is encountered when pouring is done below 1320 degrees or above 1355 degrees Cent. apparent temperature but, around 1340 degrees Cent., pouring at the scheduled pyrometer reading does not always produce the same result.

At the request of and in co-operation with the sub-committee on cast iron research of the American Foundrymen's association, the bureau of standards undertook to determine the corrections to be applied to the optical pyrometer readings on molten cast iron with particular reference to the constancy of these corrections at a given temperature. It was requested that nickel and nickel-chrome irons be included in the investigation as particular difficulty had been encountered in making optical pyrometer measurements on these irons.

Some preliminary observations were made at the Lynchburg Foundry Co., Lynchburg, Va., in connection with some other work being done by the committee mentioned above.

Five distinct mixtures of cast iron were investigated. Optical pyrometers were sighted upon the surface of the metal in ladles to obtain the apparent temperature and a platinum to platinum-rhodium thermocouple was used to obtain the true temperature. The thermocouple wires were threaded through two-hole porcelain insulating tubes and were protected by a porcelain tube inside of a graphite tube as shown in Fig. 1. The graphite tube was clamped at right angles to a long seamless steel tube to facilitate immersion in the molten metal. The thermocouples used were approximately 150 centimeters (5 feet) long of which a 50-centimeter (19½ inches) length was inside the protection tubes and the remainder in the steel tube. The thermocouple was joined to extension leads in the steel tube, thereby locating the cold junctions at a portable potentiometer which was used for reading the electromotive developed.

Optical pyrometers used were of the disappearing filament type made by the Leeds and Northrup Co., Philadelphia. The corrections obtained, thermocouple reading minus optical reading in the range 1360 to 1410 degrees Cent. (true temperature) varied from 90 to 100 degrees Cent. while in the range 1280 to 1360 degrees Cent. the corrections varied from 25 to 50 degrees Cent., indicating a higher emissivity at the lower temperatures. The results, however, were not conclusive. The apparatus and methods were in the experimental stage and the conditions were not as well controlled as in the work carried out later.

Further tests were then made at the plant of the American Cast Iron Pipe Co., Birmingham. Here essentially the same apparatus and methods were used under conditions which were better controlled than at Lynchburg. Observations were also made on the streams in a few cases. Instead of

Table II

Thermocouple and Optical Readings

Type of Iron	Thermocouple Deg. C.	Optical Deg. C.	Difference Deg. C.
Monocast, Run 450	1190 (3)	1131 (3)	59
Monocast, Run 450	1210 (3)	1151 (3)	59
Monocast, Run 450	1228 (3)	1165 (3)	63
Monocast, Run 450	1269 (3)	1222 (3)	46
Monocast, Run 450	1292 (2)	1250 (2)	42
Monocast, Run 451	1197 (3)	1177 (3)	20
Monocast, Run 451	1221 (4)	1202 (4)	19
Monocast, Run 451	1260 (3)	1238 (3)	22
Monocast, Run 455	1196 (3)	1149 (3)	47
Monocast, Run 455	1230 (4)	1194 (4)	36
Monocast, Run 457	1212 (3)	1170 (3)	42
Monocast, Run 457	1238 (3)	1204 (3)	34
Monocast, Run 457	1270 (3)	1240 (3)	30
Monocast, Run 461	1178 (3)	1126 (3)	52
Monocast, Run 461	1194 (3)	1140 (3)	54
Monocast, Run 461	1210 (3)	1163 (3)	47
Monocast, Run 461	1228 (3)	1193 (3)	35
Monocast, Run 461	1249 (3)	1211 (3)	38
Monocast, Run 461	1273 (3)	1244 (3)	29
Monocast, Run 461	1302 (3)	1273 (3)	29
Monocast, Run 461	1337 (3)	1309 (3)	28
High Carbon, Run 459	1253 (2)	1208 (2)	45
Special Foundry, Run 456	1143 (3)	1106 (3)	37
Special Foundry, Run 456	1172 (3)	1133 (3)	39
Special Foundry, Run 456	1205 (4)	1164 (4)	41
Special Foundry, Run 462	1178 (3)	1141 (3)	37
Special Foundry, Run 462	1204 (4)	1171 (4)	33
Special Foundry, Run 462	1238 (4)	1217 (4)	21
Pipe Foundry, Run 452	1156 (3)	1105 (3)	51
Pipe Foundry, Run 452	1182 (4)	1140 (4)	42
Pipe Foundry, Run 452	1232 (3)	1189 (3)	43
Pipe Foundry, Run 454	1158 (2)	1132 (2)	26
Pipe Foundry, Run 454	1182 (3)	1151 (3)	31
Pipe Foundry, Run 458	1170 (3)	1143 (3)	27
Pipe Foundry, Run 458	1195 (3)	1174 (3)	21
Pipe Foundry, Run 458	1244 (4)	1225 (4)	19
Pipe Foundry, Run 458	1248 (3)	1226 (3)	22
Low Carbon Cast, Run 460a	1297 (3)	1235 (3)	62
Low Carbon Cast, Run 460a	1324 (4)	1260 (4)	64
Low Carbon Cast, Run 463	1186 (3)	1134 (3)	52
Low Carbon Cast, Run 463	1199 (3)	1157 (3)	42
Low Carbon Cast, Run 463	1219 (3)	1189 (3)	30

Note: The figures in parentheses indicate the number of readings which were averaged to obtain the corresponding temperatures.

holding the iron in ladles for obtaining observations, the iron was poured into dry sand solds, 10 inches in diameter and 10 inches deep, rammed in a section of a 16-inch iron pipe. This was done to obtain relative cooling rates under uniform conditions and freezing points of the metal which were of interest to the foundrymen.

Several methods were used for obtaining measurements on streams. For observations on streams of special foundry iron, a 250-pound ladle was supported under the runner and the iron permitted to run into and overflow the ladle. The thermocouple was held in the ladle and optical pyrometers were sighted on the stream entering and leaving the ladle. The average of these latter values was taken as the apparent temperature of the iron.

For observation on blast furnace iron the thermocouple was held in the molten iron at the slag dam and the optical pyrometer was sighted on the metal just as it flowed under the dam and into the runner.

Some observations were made on streams of pipe foundry iron by holding the thermocouple in the iron at the bottom of the stream entering a 3-ton ladle. The optical pyrometer was sighted on the stream at the lowest visible point. Other observations were made on the same iron by holding the thermocouple in a hand ladle held under the lip of the runner. Optical readings were made on the metal as it came over the edge of the ladle.

For obtaining observations on the streams of monocast iron, a dam was built in the runner from the cupola. The thermocouple was held in a pool of metal ahead of the dam and the optical pyrometer was sighted on the stream as it came over the dam.

Some tests were also made on streams at the American Radiator Co., Birmingham. The thermocouple was placed in the mixer and optical pyrometers were sighted on the streams entering and leaving the mixer, the average being taken as the apparent temperature. The difference in temperature between the iron entering and leaving the mixer was always less than 20 degrees Cent.

Results of these tests on streams are given in Table IV and Fig. 2. The corrections to the optical pyrometer for the true temperature range 1270 to 1375 degrees Cent. vary from 12 to 27 degrees Cent. One observation at 1385 degrees Cent. gave a correction of 66 degrees Cent. The other observations in the range 1425 to 1460 degrees Cent. yielded corrections varying 89 to 107 degrees Cent.

Observations on ladles at Birmingham are shown in Table II and Fig. 2. All these observations were below 1340 degrees Cent. true temperature and yielded corrections varying from 19 to 63 degrees Cent., the average of all these giving a curve with practically a constant correction of 40 degrees Cent.

Corrections to the optical pyrometer appear to be independent of the carbon content for total carbon contents from 2.76 to 3.77 per cent. On melt No. 459, which was run primarily to secure readings on an iron of high carbon content, it was impossible to secure more than two or three readings before the surface of the 3.77 per cent carbon iron was completely covered with graphite.

Chemical analyses, cooling rates and freezing points of the iron investigated at Birmingham are given in Table III.

The temperature ranges covered in all the above tests were not wide, as they had to be limited to those of the iron coming from the cupolas in the ordinary routine of the plant. However, the results of these tests indicated that the emissivities of streams of ordinary cast iron were much higher below 1375 degrees Cent. than above this temperature. To investigate this phenomenon, on ladles, further work was carried out in the foundry of the bureau of standards where it was possible to vary conditions at will and to thoroughly cover a wider temperature range.

Table IV

Simultaneous Temperature Readings

Type of Iron	Thermocouple Deg. C.	Optical Deg. C.	Difference Deg. C.
Monocast	1372 (4)	1360 (4)	12
Monocast	1381 (3)	1360 (3)	21
Pipe Foundry	1272 (4)	1249 (4)	23
Pipe Foundry	1288 (4)	1261 (4)	27
Pipe Foundry	1306 (5)	1293 (5)	13
Pipe Foundry	1308 (5)	1283 (5)	25
Pipe Foundry	1309 (3)	1295 (3)	14
Pipe Foundry	1312 (4)	1294 (4)	18
Pipe Foundry	1323 (6)	1310 (6)	13
Special Foundry	1374 (5)	1359 (5)	15
Special Foundry	1385 (5)	1319 (5)	66
Blast Furnace	1425 (7)	1323 (7)	102
Blast Furnace	1448 (5)	1341 (5)	107
American Radiator Co.	1452 (6)	1363 (6)	89
American Radiator Co.	1460 (5)	1371 (5)	89

Note: The figures in parentheses indicate the number of readings which were average to obtain the corresponding temperatures.

Receives Appointment

Ashley P. Peck was recently appointed Chicago district sales representative of the Palmer-Bee Co., Detroit, manufacturer of speed reducers, flexible couplings, conveying equipment, etc. His headquarters will be 937 Monadnock block, Chicago. Mr. Peck was graduated from Purdue university, since which time he has been active in machinery merchandising.

Table III

Properties of Cast Irons Run at Birmingham

	Monocast					Pipe Foundry			Special Foundry			Low Carbon		High Carbon
	450	451	455	457	461	452	454	458	453	456	462	460(a)	463	459
Total carbon	3.55	3.55	3.42	3.58	3.60	3.60	3.60	3.57	3.58	3.64	3.63	2.76	3.37	3.77
Manganese	0.53	0.59	0.51	0.75	0.37	0.37	0.48	0.49	0.45	0.40	0.38	1.16	0.30	0.53
Phosphorus	0.71	0.70	0.72	0.68	0.70	0.81	0.84	0.79	0.74	0.78	0.75	0.12	0.54	0.77
Sulphur	0.093	0.092	0.092	0.081	0.085	0.072	0.069	0.058	0.076	0.067	0.067	0.099	0.084	0.057
Silicon	1.45	1.42	1.42	1.73	1.57	1.71	1.72	1.68	1.70	1.69	1.32	2.12	1.49	1.80
Copper	0.05	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.04	0.09	0.02
F. P. (solidus), Deg. C.	1149	1148	1161	1145	1139	1133	1135	1137	1136	1135	1138	.....	.....	1139
Cooling rate, in Deg. C./min.	20.0	19.0	19.5	20.5	19.5	21.5	20.0	22.5	20.0	19.0	21.5	20.0	15.0	17.0
Temperature range, Deg. C.	1291-1251	1276-1238	1245-1206	1261-1220	1294-1255	1197-1154	1195-1155	1230-1185	1235-1195	1220-1182	1268-1225	1318-1198	1221-1206	1257-1223

SMALL JOBBING SHOP

Transports Materials Easily

Special Consideration Given to Handling Problems in Laying Out New Gray Iron Foundry in Michigan

ECONOMICAL and speedy transportation of materials merits primary consideration in the design of a modern foundry. The enormous tonnages of cast products produced in automobile, radiator, pipe, jobbing and other classes of foundries, are possible only through the application of material handling equipment best suited to the particular conditions existing in the foundry. Conveyors, cranes, hoists, monorail equipment, industrial trucks and numerous other types of equipment are used independently or are combined into a system of transportation capable of meeting peak production demands.

Most of the large fouudries today are cutting costs with modern equipment, and the industry as a whole has come to recognize it as common practice. However, numerous smaller foundries are not so well equipped. For that reason, a small jobbing shop which has provided for the efficient transportation of materials, is of interest to those facing the problem.

The materials handling feature has been given considerable study in the new gray iron jobbing shop of the Superior Foundry Corp., Grand Rapids, Mich., which was placed in operation last summer. Through the use of a series of cranes and transfer tracks, it is possible easily to move materials in any department or from one department to another. Other features included in that plant are excellent storage facilities for coke, pig iron, sand, patterns, etc.; good ventilation; proper light; and ample floor space for the workmen. These factors were considered carefully by the management at the time the building was planned. Co-ordination of these various features has resulted in an ideal, small, jobbing shop for the class of work produced.

A description of the general layout of the foundry will illustrate better the effectiveness of the transportation system. The floor plan of the foundry is shown in Fig. 2. The building is built of brick and steel, and is 80 feet wide and 175 feet long. The front portion of the building is 2 stories high with the office, a small pattern shop, the shipping department and a portion of the chipping and grinding room on the ground floor and the pattern storage on the second floor. The pattern storage is approximately 20 x 80 feet and 8 feet high, thus providing ample room for a large number of patterns. The pattern storage is exceptionally light, due to the windows in the front and at the sides of the room and to the fact that the interior is faced with white brick. Patterns may be lowered from the pattern storage to the foundry floor

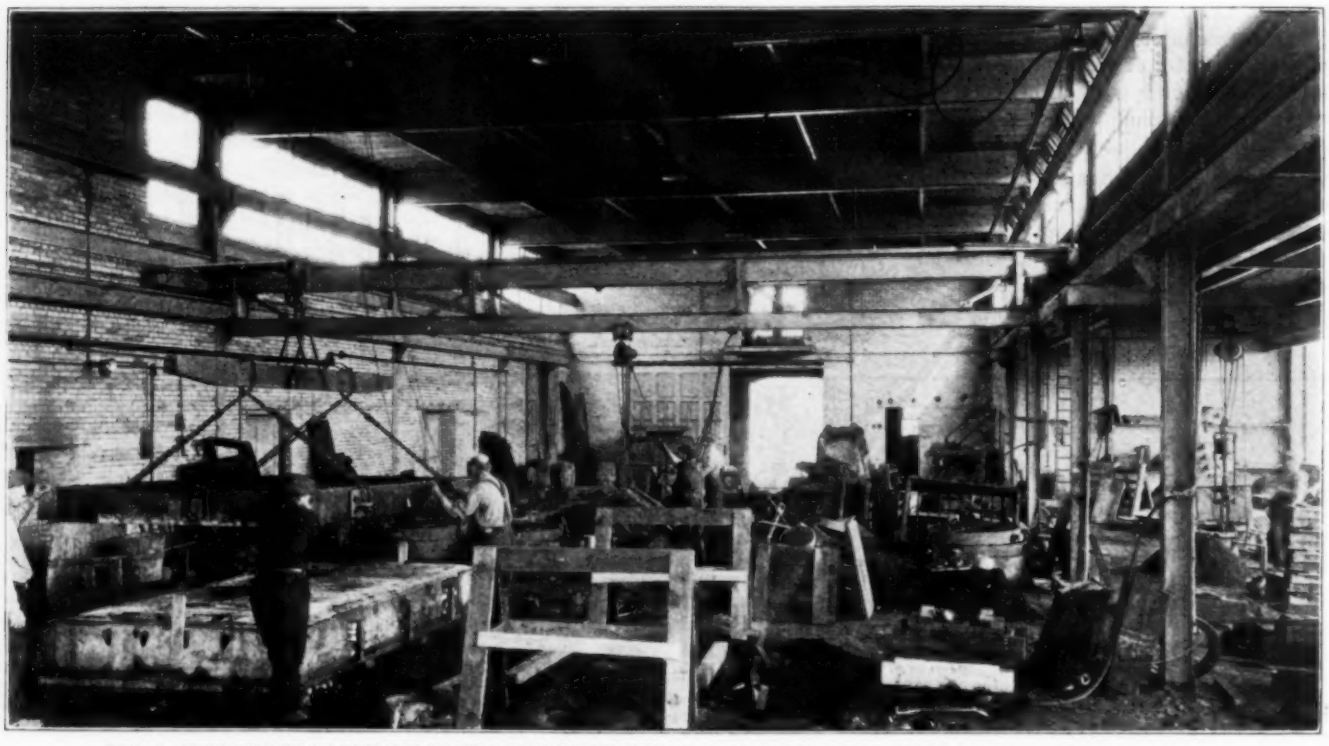


FIG. 1—TWO CRANES OPERATE IN THE MAIN BAY WHILE A SMALLER UNIT IS LOCATED IN THE SIDE BAY

through the door shown in the background of Fig. 1.

The main foundry bay is 40 x 140 feet. As may be noted in the accompanying illustrations, a small bay is located on one side of the main molding bay, while the sand storage, furnace room, compressor and blower room and cleaning rooms are on the opposite side. Core-sand, storage bins and the core oven are built at the back end of the molding bays. The larger bay is used for floor work, the castings ranging in size from the large die shown in the process of molding in Fig. 1, to manhole covers, etc. The smaller bay is designed for machine molding and small floor work.

Cores required for the class of work produced are made at one end of the small bay, near the coreroom, as shown in Fig. 2. These cores are baked in a coke-fired, rack and car type oven, which was designed by the company. A small, gas-fired, core oven built by the Monarch Engineering & Mfg. Co., Baltimore, is located near the large core oven and is used for the small cores. Stock cylindrical cores are made on an extrusion type machine built by the American Foundry Equipment Co., Mishawaka, Ind.

Facilities are provided to produce aluminum patterns and any other nonferrous castings which may be required. Three coke-fired, pit-type furnaces are located in a small bay constructed in a line with the sand storage bins, as shown in Fig. 2.

The material handling equipment in this jobbing shop, as has been mentioned, is especially well designed. Hand operated cranes are so interconnected that materials may be carried from one end of the foundry to the other with only one lift. The large molding bay is equipped with a 3-ton, air-operated, traveling crane and a 1-ton, hand-operated, traveling crane. Two runways are provided, as may be noted in Fig. 1, with the air operated crane running on the high track and the hand crane operating on the lower runway. The hand crane has a monorail suspended from the main supporting member and the trolley supporting the chain hoist operates over this monorail. The construction of the hand crane is shown clearly in Fig. 1. Both of the large molding bay cranes have a span of 38 feet 3½ inches.

A smaller, hand-operated, traveling crane is provided in the side bay. This crane has a single I-beam suspended from the main trolleys and the trolley carrying the chain hoist operates over the I-beam. The monorail suspended from the hand crane in the main bay and the crane monorail in the side bay are the same height from the floor level. Three transfer tracks are provided between the cranes in the two bays. As shown in Fig. 1 and indicated in Fig. 2, one transfer track is located at the far end of the building, near the core oven, the second is approximately in the center of the bay and directly opposite the cupola spout, and the third is near the front end of the building.

With the crane equipment constructed in that manner, it is possible to pick up a load in the side bay, move the crane to the transfer track, spot the large hand-operated crane at the opposite side of the same transfer track and run the trolley supporting the chain hoist over the transfer track and on monorail of the large crane. By moving that crane over the runway, the load may be carried to any part of the main bay. By spotting the large hand crane at the center transfer track, metal may be carried from the cupola spout, which extends through a hole in the wall, directly to any point in the side bay. It is possible to pour off the floors in an exceptionally short time by using the two hand cranes and the air-driven crane.

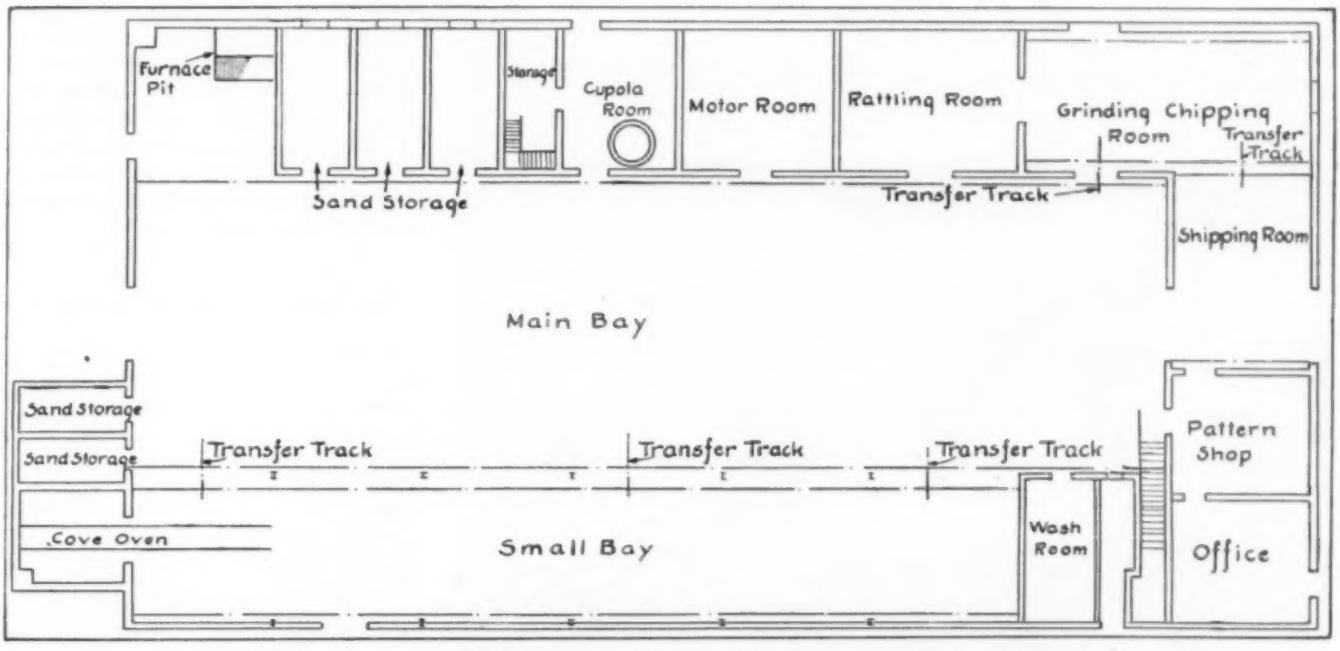


FIG. 2—LAYOUT OF THE FOUNDRY SHOWING THE COMPACT ARRANGEMENT OF THE VARIOUS DEPARTMENTS

However, the flexibility of the system of material handling equipment does not end with the cranes in the molding bays. A hand-operated crane, similar to the one in the small bay, is located in the grinding and chipping room, as may be noted by the runways indicated in Fig. 2, and another crane of the same type is provided in the shipping department. These cranes are moved over the runway by a chain which drives a gear and ratchet. The crane is equipped with safety devices which prevent the trolley supporting the chain block from running off the monorail.

As shown in Fig. 2, a transfer track has been constructed between the main foundry bay and the chipping and grinding room, so that loads carried by the crane in the main bay may be moved directly to the crane

in the grinding department, simply by spotting the two cranes in position at the transfer track. The one remaining transfer track is located between the shipping room and the grinding and cleaning department, as shown in Fig. 2. Thus, it is possible to transfer materials from the vicinity of the core department to the shipping room with only one lift. All of the crane equipment described was built by the Chisholm-Moore Hoist Corp., Tonawanda, N. Y.

Metal is melted in a cupola built by the Whiting Corp., Harvey, Ill. and scrap are piled near the cupola thus the heavier materials are moved the shorter distance.

Materials to be charged in the cupola are carried to the second floor storage on a belt conveyor, built by the Newaygo Engineering Co., Newaygo, Mich., and shown in Fig. 3. The conveyor is suspended from a trolley which travels on a monorail located under the canopy shown in the illustration. The unit is supported by two wheels shown at the bottom of the conveyor frame. With this arrangement it is possible to move the

FIG. 3—MATERIALS ARE CARRIED TO THE CHARGING FLOOR AND STORAGE BINS ON A BELT CONVEYOR

The unit has a capacity of from 10 to 12 tons an hour. As may be noted in Fig. 2, the cupola is housed in one of the rooms built along one side of the foundry building. The spout extends through an opening in the brick partition, so that the metal is delivered to the ladle in the main foundry bay. A stairway in the storage room leads to the charging platform and storage on the floor above. Air for the cupola is supplied by a blower, made by the Buffalo Forge Co., Buffalo, and housed in the motor room adjacent to the cupola room. The motor room also contains an air compressor built by the Ingersoll-Rand Co., New York.

An exceedingly ingenious layout has been developed to handle and store the pig iron, scrap, coke and limestone needed for the cupola. The charging platform and storage bins are located above the cupola room and the three sand storage bins. Coke is stored at the remote end of the room from the cupola, while the pig iron conveyor along the monorail track to any one of the three openings provided in the side of the building. The conveyor belt is equipped with cleats. Materials to be carried to the charging floor are unloaded from railway cars spotted on the sidetrack, which is shown in Fig. 3, directly on the belt conveyor. A chute carries the materials from the end of the conveyor into the storage room. Storage space is provided for 100 tons of coke. Sand used in the foundry is unloaded from railroad cars on the siding directly to the bins through the doors shown in Fig. 3.

The rattling room contains two tumbling mills built by the W. W. Sly Mfg. Co., Cleveland. A short monorail with chain block equipment is providing for loading the larger of the two mills. Portable grinders manufactured by the Ingersoll-Rand Co., New York, are used for grinding.

Henry Marckwardt is president of the Superior Foundry Corp. and Paul J. Hake is general manager.

To Discuss International Iron Specifications

Recently the council of the Institute of British Foundrymen at a meeting in Birmingham decided to communicate with Mr. Ronceray, secretary of the International test bar committee regarding a meeting of that body during the international foundry convention to be held at London, in June. The institute suggested that each national association send one delegate for a membership up to 500 and a further delegate for every 500 over the first. After a thorough investigation the council of the Institute of British Foundrymen is of the opinion that the British Engineering Standards association specification for gray cast iron would form a suitable basis for discussion for adoption as an international specification for gray cast iron.

To Study Iron Alloys

Research in iron alloys is planned by the Engineering Foundation in cooperation with the American Institute of Mining and Metallurgical Engineers. Following a conference of representatives of producers and consumers of iron and steel, technical societies, government bureaus and universities under the direction of J. W. V. Reynders, president, A.I.M.M.E., a committee of research on alloys of iron has been appointed. John Johnston, director of research and technology, U. S. Steel Corp., New York, is chairman. Other members of the committee are F. M. Becker, Union Carbide & Carbon Research Laboratories, Long Island City, N. Y.; H. W. Gillett, chief of division of metallurgy, U. S. bureau of standards; James T. MacKenzie, metallurgist and chief chemist, American Cast Iron Pipe Co., Birmingham, Ala., and A. J. Wadhams, manager of research and development, International Nickel Co., New York. The initial task of the committee is to provide a critical five-year review of all available literature in English and other languages which is estimated to cost $150,000.

Foundries To Merge

Negotiations with a view to amalgamations between the owners of a number of English foundries now are well advanced. It is stated that a merger involving 16 foundries is to be concluded in the near future. Should this event materialize, about 65 per cent of the output of rainwater goods will be under one control.

How and Why in Brass Founding

By Charles Vickers

Mold Is Cause of Scrap

We find porosity in castings made of an alloy 88 *per cent copper;* 6 *per cent tin;* 3 *per cent zinc;* 3 *per cent lead. One pound of an alloy of* 50/50 *copper nickel to condense the grain of the metal, is placed in the pot before charging. We are forwarding a small flange faced on the flange surface to show the holes that develop. In making these we lost* 10 *per cent. In larger castings, weighing about* 4 *pounds, we lost under* 3 *per cent from this cause. We cover our crucibles with charcoal, in coke-fired pit furnaces. The charge generally contains* 50 *per cent gates of the same mixture, but many times we use all new metal and the thought has occurred that this may be the cause of our trouble.*

The foundry practice seems good enough to produce castings free of all gases, but evidently it does not do so. The question immediately arises: why is the loss confined to a small proportion of the castings? If the metal was gassed uniformly from the top to the bottom of the crucible, how could any of the castings come sound? Perhaps the trouble does not lie in the metal, that it results from some condition of the mold which makes certain of the castings come unsound. In other words certain castings get filled with gas from the mold. When we study the mold and reflect that it is only composed of wetted sand we wonder how we have the temerity to pour molten brass into such a thing. We know that moisture and molten metal never should be brought together. The result is likely to be a disastrous explosion, due to the sudden generation of steam by the great heat of the molten metal.

Certain places in the cope, particularly around the sides of the flask are apt to get spanked with the butt rammer a trifle more than they should be. When the hot metal hits this harder surface it objects. It cannot lie against it until it has dried out, and as the sand above those spots is denser than the rest of the mold, the steam leaves the vicinity of the molten surface reluctantly. In fact it spitefully insists on penetrating the metal as little darts or jets of gas under pressure and it stays long enough to make real holes into the brass. The sample casting shows that it has been penetrated by steam from the cope. To avoid this porosity it is necessary to pay attention to the manner in which the copes are rammed. Have them rammed evenly over the patterns. Around the sides, of course, the sand has to be rammed hard enough so that the cope does not *fall out* in closing.

Using all new metal cannot have the least effect in causing porosity. The new metal alloy ought to be better than the half new, half gates, because the gates in small sections expose more surface than the ingot copper to the furnace gases. They are likely to absorb the furnace gases, sulphur and the carbonic oxides, which with steam furnishes hydrogen and causes porosity. The three principal gases in porous castings are carbon monoxide, hydrogen, hydrogen sulphide or sulphur dioxide, with carbon dioxide in small amount. The metal in this case is all right. The porosity is due to hard ramming of certain parts of the copes. As has been said before, special attention must be given to ramming to prevent a recurrence of this fault.

Molding Bronze Letters

We are sending you a sample of a small bronze "A" for attaching to patterns and will appreciate your telling us how these are made. We are of the opinion they were cast in metal molds and of a composition metal suitable for that purpose.

This letter has short prongs cast on the back so that it can be driven into a wood pattern and be held there. These prongs complicate the molding process, because minus the prongs it is easy to shellac such letter patterns onto a plate fitted with the necessary runners and gates, and then put up about 100 molds and thus get a multitude of letters in short time. With the prongs the latter would be on one side of the plate and the letter on the other which introduces a nice job of plate making, also a costly one.

So all things considered we feel that a *gate* of patterns would be the best way of making these letters and one runner would serve a double row of letters on either side. Some nice castings could be made in this manner, using a No. 00 brass sand with possibly a little flour mixed in some of it for a facing, as this flour produces a smooth surface on the casting, and is better in every way than pitch.

We do not subscribe to the opinion of these letters being cast in metal molds. Such molds work well for white metals, but nobody so far has been successful with the casting of red brass in metal molds of any kind, and especially such small castings. The prongs would interfere here too, for half of the time they would not run up, and when they did run up they would break off if the hot castings were tilted in taking them out of the mold. We believe that sand casting is the quickest and cheapest method of making such tiny castings. A nice alloy we should imagine would be copper, 88 per cent; tin, 5.50 per cent; zinc, 3.50 per cent, and lead, 3 per cent.

Inserts Water Coil

We are making water-cooled, brass bearings weighing 200 *pounds. Please advise the best method of securing the coil in the mold. Would you advise the use of copper or of iron pipe?*

It is difficult to suggest a method of securing the pipe in the mold, since you did not furnish a sketch with the question. Whether the pipe is straight or crooked, it resembles a core, and will need core prints on the pattern like a core. Also, the pipe will have to be long enough to fill its prints. If it is elbow-shaped and consequently, likely to twist and cut through the casting, then it will have to be anchored securely so that it will stay where it is put. In such a case the molder will have a chance to exercise his skill. The pipe will have to be heated before putting in the mold. Therefore, the cope of the mold should not be closed until pouring time. We would prefer iron pipe, as both metals will blow equally well. There is not much to choose between them, but the copper pipe might be cut through by the metal and this would ruin its career at the start.

Melting Steel

in the

High Frequency Furnace

By Heinz Neuhauss

FOR producing a stainless steel containing 13 per cent chromium and using high-carbon ferrochromium, 138 kilograms (304 pounds) chromium metal (25.4c per kilogram or 11.5c per pound) per gross ton are necessary (costing $36 per gross ton), and using ferrochromium containing 0.10 per cent carbon, 130 kilograms (286 pounds) chromium metal (66c per kilogram or 30c per pound) for one gross ton ($86 gross ton) are necessary. The price difference of $50 per ton seems to make the previously described method practicable.

Decarburizing of the ferrochromium also requires a high temperature bath as in the described stainless steel experiment. With increasing temperature the affinity of carbon becomes so great that chromium is protected from oxidation. In spite of this the great concentration of chromium causes a long oxidation period.

Fig. 10 and Table VII give all data obtained from two practical experiments. For the decarburization a ⅛-horsepower air blower and iron oxide were used. Iron oxide was added and cold air blown directly on the clear bath surface. The insufficient decarburization obtained in the last 2 hours of the second experiment show that the air blower did not furnish sufficient oxygen. The aim of these two experiments was, not to discover to best decarburizing conditions but to demonstrate the future of the coreless induction furnace for this purpose. No other furnace can furnish better condi-

May Extend Use

THIS is the second and concluding installment of a series giving information on the high frequency furnace as a melting unit for steel production. The author presents some figures on power consumption for producing stainless steel and also some data on the possibilities of this furnace in connection with a cupola melting all steel scrap as a duplexing unit for steel foundries.

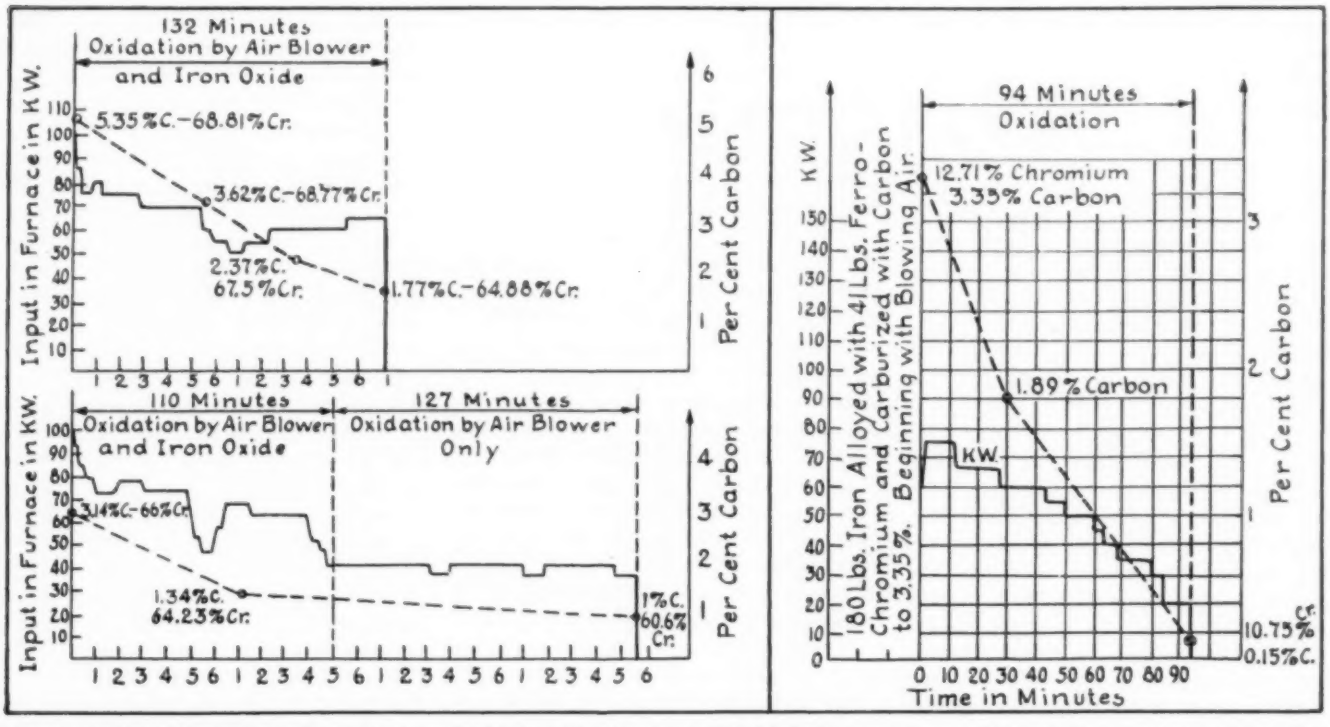


FIG. 10—GRAPHICAL REPRESENTATION OF DECARBURIZATION OF FERROCHROMIUM. FIG. 11—PRODUCTION OF STAINLESS STEEL BY DECARBURIZATION OF CHROMIUM BEARING PIG IRON

tions for this purpose, that is, the possibility to superheat in absence of carbon and the stirring action which starts the reaction through the whole bath and not at the surface alone as in other furnaces with quiet bath. Preheated air blown on the clear bath surface would be the most successful way for decarburization.

In reviewing the different experiments made in the high frequency furnaces it seems possible to avoid completely the use of ferrochromium by producing in a blast furnace a 15 per cent chromium containing pig iron directly from the ore, charging it into the high frequency furnace and decarburizing it. Fig. 11 shows the results of a practical experiment with a 221-pound charge to change a synthetic pig iron containing 3.35 per cent carbon and 12.71 per cent chromium to stainless steel by decarburizing. After one hour and thirty-four minutes the analysis was 0.15 per cent carbon and 10.7 per cent chromium. This steel was forged and rolled in a sheet which was exhibited at the National Metal Exposition in Philadelphia, in October, 1928. Cold air was blown by a ⅛-horsepower air blower on the clear bath surface, and iron oxide was added at the same time. The reaction was so violent that the metal boiled over twice. Corresponding to the resulting lower weight, the power was reduced near the end of the melt. After the above described action of the charge no exact data about oxidation losses can be given, but it is believed that the metal losses of the described process when using larger furnaces and preheated air as an oxidizer will remain within the limits of the normal open hearth and bessemer processes.

A 12-pound furnace which was connected with an air heater and blower gave results as follows:

The synthetic pig iron with 3.74 per cent carbon and 12.89 per cent chromium was blown down to 0.88 per cent carbon and 11.33 per cent chromium in 52 minutes.

Data contained in this article are not complete, but they show that this method is practicable and give hope for a cheaper stainless steel.

Small, 100-cubic meter (3500-cubic foot) capacity blast furnaces with steep section of boshes and tall shafts are used to produce ferrochromium. A 15 per cent chromium pig iron could be produced in a furnace of this type. Low chromium containing iron ores and high iron containing chromium ores could be utilized.

A large output can be obtained if the high frequency furnace is charged with liquid metal and used to refine alloy and deoxidize steel only. As previously described pure iron was deoxidized in 12 minutes; coppered iron and commercially pure iron were finished in 11 or 18 minutes after melted, stainless steel containing 13 per cent chromium was alloyed and deoxidized in 13 minutes. Greater practice in these processes will lessen considerably the time required.

The liquid charge is easily available in all open hearth or converter steel plants, but in other plants it

Table V

Made With High Carbon Ferrochromium

Charge: 198 pounds scrap
52 pounds ferrochromium with 5.6 per cent carbon; 68.8 per cent chromium.

Lining: Magnesia crucible cold

Power used in melting the base iron.	Charge: 198 pounds. Time: 39 minutes. (slow preheating of the crucible) Average charge: 111 kilowatts. Input in furnace: 72 kilowatt hours. Input in generator: 72 / 0.75 = 96 kilowatt hours.
Power used in melting the addition.	Charge: 52 pounds. Time: 13 minutes. Average charge: 123.7 kilowatts. Input in furnace: 26.8 / 0.76 = 35.2 kilowatt hours. (316 kilowatt hours per gross ton.)
Power used in decarburizing.	Time: 65 minutes. Average charge: 73.5 kilowatts. Input in furnace: 80 kilowatt hours. Input in generator: 80 / 0.74 = 108 kilowatt hours. (950 kilowatt hours per gross ton.)
Power used to finish the melt.	Time: 12 minutes. Average charge: 26.5 kilowatt hours. Input in furnace: 5:3 kilowatt hours. Input in generator: 7 kilowatt hours. (63 kilowatt hours per gross ton.)
Analysis	0.04 per cent Carbon 13.49 per cent Chromium 0.41 per cent Manganese 0.22 per cent Silicon 0.005 per cent Phosphorus 0.028 per cent Sulphur

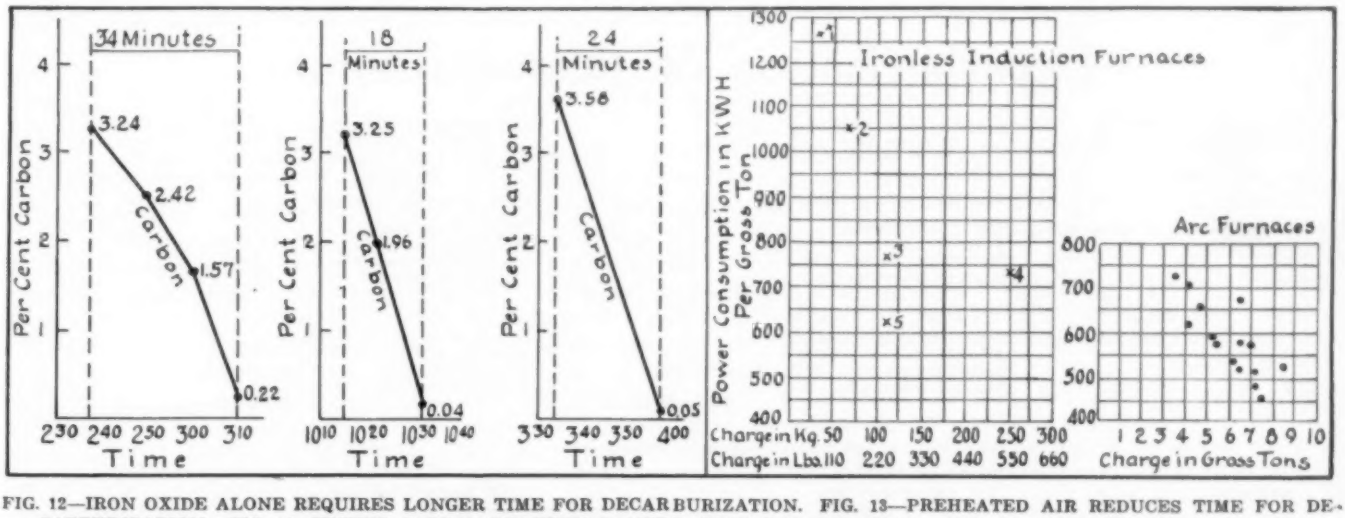


FIG. 12—IRON OXIDE ALONE REQUIRES LONGER TIME FOR DECARBURIZATION. FIG. 13—PREHEATED AIR REDUCES TIME FOR DECARBURIZATION. FIG. 14—HIGHER CARBON REQUIRES LONGER TIME FOR REMOVAL. FIG. 15—COMPARISON OF POWER CONSUMPTION OF TWO TYPES OF FURNACES

Table VI

Gives Power Consumption Data

No.	Generator	Charge	Power consumed per gross ton kwh.	Lining	Measured by
1	30 kw.	30 kg. (66 lb.) 40 kg. (88 lb.)	1265 1280	adhesive sand, used still warm	German Iron & Steel Institute, Dusseldorf
2	150 kw.	65 kg. (143 lb.)	1050	adhesive sand, used still warm	Ajax Electrothermic Corp.
3	150 kw.	109 kg. (239.8 lb.)	770	adhesive sand, used still warm	Ajax Electrothermic Corp.
4	150 kw.	225 kg. (495 lb.)	728	graphite containing clay crucible (great average of melting high speed steel)	Edgar Allen & Co. Works, Sheffield

is quite difficult to obtain. Melting steel scrap in the cupola furnace is a method with a future. T. F. Jennings, Garfield, Utah, says in his paper published in the *Transactions*, American Foundrymen's Association, Vol. 34, that "At the present as for the last two years, we are melting heats of 30 tons daily for 7 days a week in a large pair of cupola furnaces with a 54-inch lining. The two cupolas are used alternately, one in operation and one under repair."

In a personal letter to the author, T. F. Jennings gave the following information: "At the present time we are running about 85,000 pounds a day in a cupola made by the Whiting Corp., Harvey, Ill. We use coke made from Ashland Kentucky coal." The cupola is 54 inches in diameter inside of the lining.

Frank Hudson adds in the discussion of T. F. Jennings' paper the following facts about steel melting in the cupola furnace: "Cupola lined to 45 inches inside diameter with rated capacity of 8 tons per hour. Coke on bed charged 2240 pounds. All steel charges used 2240 pounds. Coke on charges weighed 280 to 308 pounds according to the conditions of the steel being melted. Melting ratio excluding weight of bed coke 1 to 7.4. Average analysis using 16 pounds of 80 per cent ferromanganese and 60 pounds 50 per cent ferrosilicon is:

Per Cent	Element
3.00	Carbon
1.02	Silicon
1.23	Manganese
0.086	Phosphorus
0.082	Sulphur

A coke of not less than 90 per cent fixed carbon and low ash content must be used."

For our purpose it would not be necessary to add silicon and manganese in the cupola furnace so a liquid iron with 3 per cent carbon, low in manganese and silicon would be charged into the coreless induction furnace. T. F. Jennings says: "The average analysis is: Carbon, 2.95 per cent; silicon, 0.27 per cent; manganese, 0.322 per cent; phosphorus, 0.18 per cent and sulphur, 0.103 per cent." The question then arises as to how quickly this iron can be decarburized in the high frequency furnace. The stirring action in the high frequency furnace shows that this can be done very quickly as proved by practical experiments conducted by the author at Ajax Park, N. J., in a 12-pound furnace. Using iron oxide, 34 minutes were necessary to decarbonize from 3.24 per cent carbon to 0.22 per cent carbon as shown in Fig. 12. The best way is to use preheated air blown on the bath surface so that a kind of electric converter is established. In this experiment, Fig. 13 and Fig. 14, preheated air at approximately 400 degrees Cent. was blown on the bath surface in the crucible. Eighteen minutes were sufficient to decarburize the bath from 3.25 per cent to 0.04 per cent carbon, and 24 minutes were sufficient to decarburize the bath from 3.58 per cent to 0.05 per cent carbon.

The experiments described were carried out in a small capacity furnace where the frequency was probably as high as 30,000 to 40,000 cycles. When a motor generator operated large furnace is used, frequencies of from 800 to 1000 cycles are applied, which result in a more violent stirring so that in practice the time of the reaction will be decreased materially.

This result shows that the proposed duplex process using a cupola and the coreless induction furnace is practicable, especially for cast steel foundries. Using a liquid charge containing 3 per cent carbon from the cupola furnaces, one cast steel charge could be finished in the induction furnace in one hour or less. The application of a 1-ton high frequency furnace with a 350 to 400 kilowatt generator would permit a production of at least 24 tons of cast steel in

(*Concluded on Page* 218)

Table VII

Decarburization of Ferrochromium

Charge 223 pounds	Analysis after melting C—5.35 per cent Cr—68.81 per cent	147 pounds ferrochromium 1.77 per cent carbon 93 pounds ferrochromium 5.35 per cent carbon Analysis after melting 3.16 per cent carbon 66.06 per cent chromium
Lining	New magnesia crucibles	New magnesia crucibles
Power used in melting and over heating charge	Time: 59 minutes Average: 124.2 kilowatts Input in furnace: 129 kilowatt hours Input in generator: 129 / 0.75 = 163 kilowatt hours	Time: 80 minutes Average: 100 kilowatts Input in furnace: 134 kilowatt hours Input in generator: 134 / 0.74 = 181 kilowatt hours
Power used in decarburizing	Time: 2 hours 11 minutes Average: 66.6 kilowatts Input in furnace: 145.5 kilowatt hours Input in generator: 145.4 / 0.74 = 195 kilowatt hours	Time: 3 hours 57 minutes Average: 50.3 kilowatts Input in furnace: 198.8 kilowatt hours Input in generator: 198.8 / 0.74 = 268 kilowatt hours
	Calculating 10 per cent loss of metal during oxidation: 2180 kwh/gr. ton	Calculating 10 per cent loss of metal during oxidation: 2680 kwh./gr. ton
Analysis:	1.77 per cent carbon 64.88 per cent chromium	1.00 per cent carbon 60.56 per cent chromium

METAL AND MELTING PROBLEMS

Metallurgical Advice on Gray Iron, Malleable and Steel

Jobbing Shop Desires to Make Grate Bars

Question—We desire to manufacture grate bars to withstand an unusually high temperature. We have secured some pig iron having the following analysis.

	Per cent
Silicon	1.79
Sulphur	0.014
Phosphorus	0.24
Manganese	0.74

Our problem is to obtain the proper mixture of pig iron, cast iron scrap and steel scrap to enable us to obtain a casting that will stand up. As we have a jobbing foundry, we must take this mixture off first and then, when it is entirely out of the cupola take our melt for machinery castings.

Answer—The idea in making grate bars to withstand high temperature is to have fairly high sulphur and the silicon so low that the iron will be as hard as possible without being brittle. In a jobbing foundry it would not be practical to endeavor to secure high sulphur in your iron as your other metal likely would be affected. The only thing open to you is to hold the silicon down to get a fairly hard iron. The pig iron you mentioned in your letter would give you such results if mixed 40 per cent pig iron and 60 per cent fair grade machinery scrap. You would have quite a leeway with the scrap you use. The only precaution necessary would be to see that the grate bars were hard but not so hard that they crack readily. If you desire to do so you can substitute 10 to 15 per cent steel scrap for a like amount of cast iron scrap.

Phosphorus Is Too High

Question—We have a gray-iron jobbing foundry, making automobile pistons, washing-machine and furnace castings, steam shells, valves, and other steam specialty castings. We try to run a mixture suitable for all our customers' machine shops. Our mixture is made up of 500 pounds of pig iron containing 1.47 per cent silicon, 0.014 per cent sulphur, 1.10 per cent phosphorus and 1.04 per cent manganese; and 1500 pounds of pig iron containing 3.00 per cent silicon, 0.041 per cent sulphur, 0.75 per cent phosphorus, 0.71 per cent manganese. Leaks develop in the valves under steam pressure. What mixture should we use to get soft castings for the light machine work, and also have a close grain in the valves?

Answer—The mixture that you give appears to be all pig iron and we would suggest the use of 40 per cent sprues, gates and scrap castings from the same mixture, that is, a mixture of 60 per cent pig iron and 40 per cent scrap iron in the cupola. An iron with 1.10 and 0.75 per cent phosphorus undoubtedly would tend to cause leaky valve castings. The phosphorus should not be above 0.3 per cent of these castings. An analysis of some of the defectives would help in answering the question.

Scrap Annealing Pots

Question—Is it practical to melt scrap annealing pots used in making malleable iron on the end of the heat to be used for snap weights, sash weights, etc.?

Answer—It has not been found pratical to melt scrap malleable annealing boxes in the cupola. They are covered with a heavy coating of oxide which would require a great amount of limestone to flux off, and even then only a small percentage of the box is metallic iron. For this reason, the scrap pots are usually sold to blast furnaces for reduction.

Dirt Is Not Removed

Question—Would it be feasible to add a small quantity of metallic aluminum to each ladle of molten semisteel to prevent accumulation of dirt?

Answer—The addition of aluminum to semisteel will in no way help to prevent the accumulation of dirt, but on the contrary, if the metal is oxidized or the aluminum becomes odidized before it unites with the iron, it will form aluminum oxide slag which would not separate readily out of the iron. Aluminum has the property of causing graphite to precipitate in the iron, thus softening it. It also increases the electrical resistance of the iron and one electrical company uses about 5 per cent aluminum in iron for resistance grids.

Melting Loss on Stove Scrap in Cupola

Question—Can you give us any authoritive figures on the melting loss of stoveplate scrap in the cupola. We have been told that actual tests showed a loss of 25 per cent. If that is true and based on present prices we should find it cheaper to buy pig iron instead of scrap. Any information you can give us on this subject will be greatly appreciated.

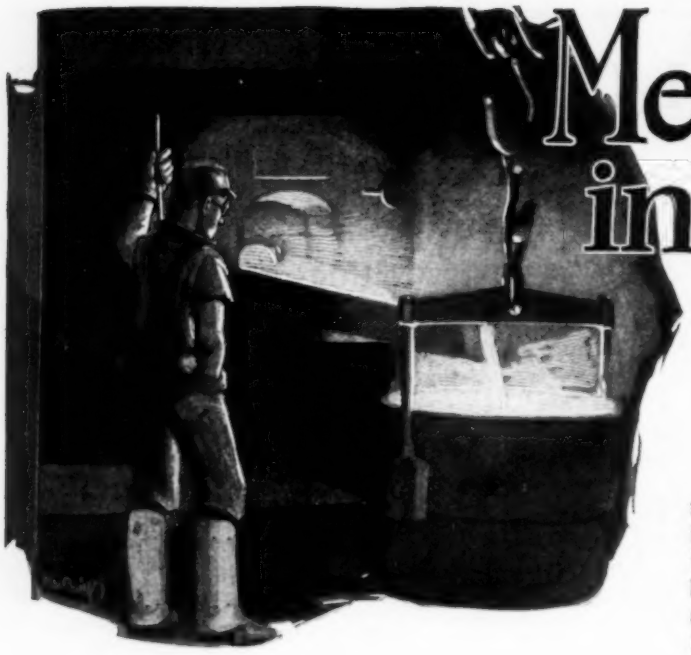
Answer—Like many other general statements at times used carelessly by foundrymen, the statement that stoveplate scrap suffers a 25 per cent loss in the cupola is partly right and partly wrong. Certain kinds of stoveplate scrap, heavily rusted, burned parts, thin steel plate, dirt and scale sometimes mixed in a miscellaneous lot, probably will show a melting loss of 25 per cent. Good, clean stoveplate scrap, melted under proper conditions will yield as high a return of molten iron as either pig iron or good machinery scrap. Why not?

Stoveplate is made from high grade iron with an average silicon content of 3.00 per cent, therefore when remelted it will show a silicon content of at least 2.75 per cent, the upper range by the way of No. 2 foundry pig iron.

Many years ago Dr. Moldenke made a careful investigation of cupola melting loss. The following table published in his *Principles of Iron Founding* shows the average melting loss of the several kinds of foundry metal entering ordinary mixtures:

	Per cent
Machine cost pig iron	0.30
Sand-cast pig iron	1.00
Car wheels	2.00
Heavy machinery scrap	2.50
Light machinery scrap	3.50
Stoveplate scrap	8.00

In explanation of the high figure given for stoveplate scrap he explains that usually this is pretty light material which accumulates for a considerable time in the yards of the scrap dealers. In some instances this material may lie rusting for years before it finally reaches the cupola. The coating of rust is heavy and an 8 per cent melting loss is a fair average. With many burned grate bars in the collection the loss may be 14 per cent.



Melting Iron in the Cupola

By J.E.Hurst

Part XIII

IMPROVED efficiency of the modern standard cupola is due entirely to the dimensional relationship of the various parts. Dimensional relationships involve shape and proportions of internal form of the cupola, total area and number of tuyeres, pressure, volume and velocity of the air supply. All these can be varied extensively within the limits imposed by the standard shell. A wide diversity of opinion obtains on many details and it is only possible in a work of this nature to record some of the more important and authoritative observations on the subject. Any rational system of cupola design obviously must be based on anticipated output. Melting rate, quantity, velocity and pressure of air supply have been referred to in the previous chapter and naturally lead to consideration of tuyere design, shape and effective height of the lining, well capacity and other proportions.

Usually the tuyere area is considered in relation to the cross-sectional area of the cupola at the tuyere level. Recommended ratios of tuyere area to cupola area, number of tuyeres and shape vary in almost every conceivable manner. For example, Cook recommends that the tuyere area for general work should be 1/9, and for special cylinder work 1/12 to 1/16, the cross-sectional area of the cupola. This is much smaller than tuyere sizes prevailing today in which the tuyere area usually is about 1/5 of the cupola area at the tuyere level. Slightly smaller, also slightly larger ratios than this frequently are recommended. With the idea of obtaining somewhat higher pressures a tuyere area of 17.5 per cent of the cross-sectional area is recommended for larger diameter cupolas. For smaller diameter cupolas ranging from 24 to 36 inches a tuyere area of 25 per cent or ¼ of the cross-sectional area at the tuyere level is allowable. Foundrymen now generally agree that extra tuyeres in addition to the regular single row are not necessary, providing the requisite quantity of air is passed through the cupola. A single row of tuyeres passing the correct amount of air effects a distinct saving in the height of bed coke. This view has not yet gained the adherence of all foundrymen and the majority of standard cupolas are fitted with at least two rows of tuyeres. Melters who prefer a single row, easily can close the second row.

Tuyeres Important

FOR many years opinion among foundrymen varied widely on the subject of tuyere size, position and area in relation to the diameter of the cupola. In recent years a more uniform opinion has been adopted extensively favoring more generous tuyere area than obtained formerly. Scientists have investigated the subject independently, also in active collaboration with practical cupola operators and have established definite principles governing this and many other features including types of tuyeres, relation of the wind belt to the blast main, how to determine the proper amounts of coke and iron in the charges for cupolas of any dimension. Heat developed in the cupola probably reaches 1400 degrees Cent.

The type of tuyere in which the air is expanded on entering the cupola has been adopted almost universally. The tuyeres may be either rectangular or circular in cross-section, expanding toward the cupola to twice the area at the entry. This type of tuyere has a high discharge coefficient. Compared with the parallel nozzle, the respective coefficients are 0.92 and 0.50.

Modern tendency in tuyere design is to admit air at all points around the circumference at the tuyere area, a tendency which has the advantage of maintaining the tuyeres comparatively close to the bottom and consequently holding the coke low in the bed charge. Various methods of arranging the tuyeres tangentially to the circumference have been abandoned almost completely in standard cupola design.

Y. A. Dyer, in an excellent summary of American cupalo practice states than the ratio of the tuyere area should decrease with increase of cupola area, in proportion to the size of the cupola. That is the tuyere area of a 24-inch cupola may be 20 per cent of the cupola area, while in a 90-inch cupola the tuyere area may be only slightly more than 12 per cent. He gives the ratio of combined tuyere area to cupola area in a range of fractional graduations as follows:

Cupola Diameter	Tuyere Ratio
24-42 inches	1:6
44-62 inches	1:7
64-90 inches	1:8.3

According to Dyer the ratio of tuyere area to blast pipe area is exactly the reverse of ratio of the former to cupola area. That is; the blast pipe area of a 24-inch cupola may be practically 56 per cent of the tuyere area, while in a 90-inch

cupola, the blast pipe may be 92 per cent of the tuyere area. The following relationships are given by another investigator:

Cupola Diameter	Ratio of Blast Main area to tuyere area
Up to 42-inch diam.	1:1.6 to 1:1.75
42-inch to 63-inch diam.	1:1.4 to 1:1.6
Larger diameters	1:1.1 to 1:1.4

Object of providing a larger area of blast main than the tuyere discharge nozzles is to counteract losses due to friction.

The wind belt also should bear a definite relation to the blast main and it is recommended that the ratio of sectional area of wind belt to that of the blast main should not be less than 3:1 and may be 3.5:1 or 4:1 in large cupolas.

The results given in Table XV are abstracted from data given by Dyer and are typical of American practice in this respect.

In a previous chapter dealing with velocity of gases in the cupola stack a slight flaring was recommended from the tuyère level to the top of the melting zone. Advantage claimed was that exit of the gases was retarded slightly. Gain from this probably is small over that of a definitely parallel lining.

Effective height of the cupola is measured from the top of the tuyeres to the charging door and since this is the main dimension in determining the period of contact between the hot gases and the charge, it is of major importance. Limit to the height principally is determined by the carrying capacity of coke in the bed. With more extensive adoption of mechanical charging the cost of raising the materials to the charge level, formerly a consideration which determined the height of cupolas, is not now so important and can almost be eliminated from consideration.

Height equivalent to four or five times the diameter at the tuyer level is the common rule in design. From considerations of the velocity of the blast, a relationship of 20 to 24/D has been deduced between the height and diameter. In larger cupolas this relationship gives height values considerably lower than are in common use and have been found advantageous in practice. In a formula deduced by Buzek, the effective height of the cupola is assumed to be the height from the top of the melting zone to the charging door or the top of the charge level. Height of the melting zone *Hs* is calculated as 0.5*D* where *D* is the diameter of the cupola. The bottom of the melting zone, of course, is the tuyere level. The height *Hs* is

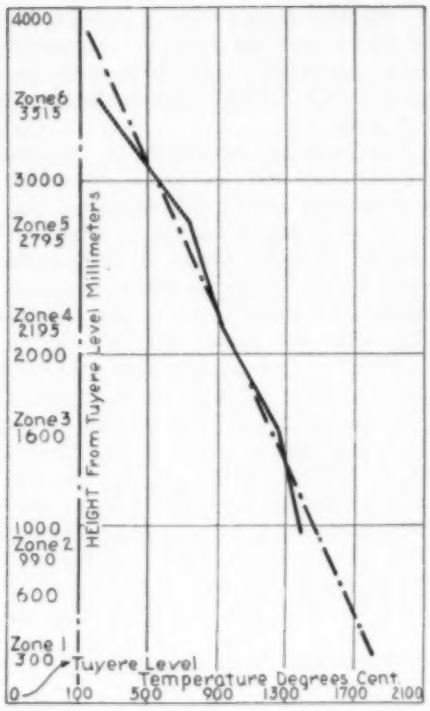


FIG. 85—TEMPERATURE MEASUREMENTS AT VARIOUS LEVELS

determined by the following relation:

$$Hs = 4/Q\ (1 - 0.05K) \quad \text{.....} \quad (1)$$

where

Q = cross sectional area of cupola in square feet.

K = quantity of coke for 100 pounds of iron.

$$Q = \frac{D^2 \times \pi}{4} \quad \text{.....} \quad (2)$$

$$Hs = 3.55 \times D\ (1 - 0.05K) \quad \text{..} \quad (3)$$

For quantities of charge coke of from 6 to 12 per cent, the value of $0.05K = 0.3$ to 0.6 and the relation then becomes:

$$Hs = 4.6D \text{ to } 5.67D \quad \text{.....} \quad (4)$$

To the figures in equation 4 the height of the melting zone $0.5D$ must be added, and the final relationship for charge coke percentages of 6 to 12 per cent becomes:

$$Hs = 5.1D \text{ to } 6.17D \quad \text{.....} \quad (5)$$

This is close to the ratio given by Pfeiffer—in which it is stated that the height should be six times the cupola diameter at the tuyere level—and checks his statement.

Dyer states the height of small cupolas should be at least sufficient to receive 6 to 8 feet of stock before starting the blast. Medium cupolas should hold 9 to 10 feet of stock and large cupolas 11 to 14 feet. From the foregoing it is apparent that the ratio of height to cupola diameter, where tuyeres are located 16 to 18 inches above the bottom, may vary from 4.5:1 to 3.4:1 in small cupolas; 3.4:1 to 3.8:1 in medium cupolas; and 2.8:1 to 2.4:1 in large cupolas used for continuous melting with low tuyeres, 6 to 8 inches above the bottom. Height of the door may be raised 6 to 8 feet for small cupolas and 10 to 12 feet for larger sizes. Height need not be so great on smaller cupolas by reason of relatively lower gas velocities.

General rule for weight of cupola metal charges is about 1/10 of the melting rate per hour in pounds. Kleinsorge in *Die Giesserei* 1926, No. 26, page 561, measured the height of the coke charge of a great number of cupolas and determined the CO_2 and

Table XIV

Suggested Data for Designing or Remodeling a Cupola

Cupola. lined diameter in.	Height bottom to charging door ft. in.	Tuyeres No.	Tuyeres Size: in.	Blast pipe diameter in.	Wind-box size in.
24	9 0	5	3 x 6 x 14	8	6 x 25
26	9 6	5	3½ x 6 x 15¼	8½	6 x 28½
28	10 0	5	3½ x 6¾ x 16½	9¼	6¼ x 32¾
30	10 6	6	3½ x 6¾ x 14¾	10	6½ x 36
32	10 6	6	3½ x 7 x 15⅝	10½	6¾ x 38⅞
34	11 0	6	3½ x 6¾ x 16⅞	11⅛	7 x 42
36	11 0	7	3½ x 7¼ x 15⅛	12	7⅛ x 44⅞
38	11 6	7	3¾ x 7⅜ x 16⅛	12¾	8 x 47
40	11 6	7	3¾ x 8¼ x 16⅞	13¼	8⅛ x 48¼
42	12 0	7	4 x 8⅜ x 17⅛	13⅞	9 x 50
44	12 0	8	3¾ x 8⅜ x 16¼	14½	9⅛ x 52
46	12 6	8	4 x 8½ x 17¼	15⅛	10 x 54
48	12 6	8	4 x 9 x 17⅜	15¾	10¼ x 56¾
50	13 0	8	4 x 10 x 18½	16½	10¾ x 59½
52	13 0	10	4 x 8 x 15¼	16¾	11 x 60
54	13 6	10	4 x 8¾ x 16⅞	17⅜	11¾ x 62½
56	13 6	10	4 x 9¼ x 16½	18¼	12 x 65½
58	14 0	10	4 x 9¾ x 17¼	18⅞	12¼ x 68½
60	14 0	10	4 x 10¼ x 17⅞	19⅝	13 x 69½
64	15 0	11	4 x 10½ x 17⅝	20⅞	14⅜ x 69½
66	15 6	11	4 x 10⅞ x 17⅞	21½	15½ x 70
68	15 6	12	4 x 10½ x 17½	22¼	15¾ x 75
72	16 0	12	4 x 11½ x 17⅞	23⅝	16 x 80⅛
78	17 0	13	4¾ x 10 x 17½	25⅝	16 x 96¾
80	17 0	14	5 x 9¼ x 16⅞	26⅜	16⅛ x 99
84	17 6	14	5 x 10 x 17¾	27¾	17 x107
90	18 6	15	5 x 10½ x 17⅞	30	17 x124⅝

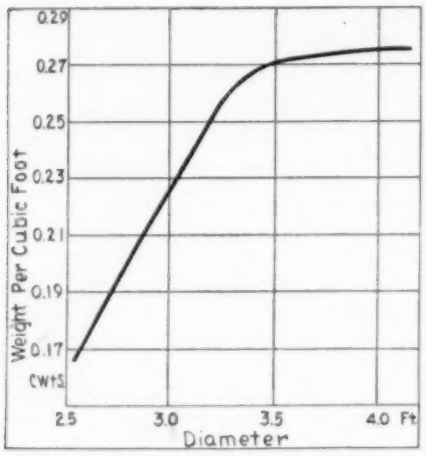


FIG. 86—WEIGHT OF COKE VARIES

CO content of the gas current. He found the most suitable height to be 0.59 feet. The weight of the coke charge then is calculated according to the following formula:
$Pc = \pi D^2 hR = 0.463 D^2 R$, where $Pc =$ weight of the coke charge, cwts.; $D =$ diameter of the shaft, feet; $H =$ height of the coke charge $= 0.59$ feet, and $R =$ weight of the coke per cubic foot.

Weight of coke per unit volume largely depends upon the diameter of the shaft, because toward the periphery the coke is heaped more loosely than in the middle. Results of experiments undertaken in this direction are recorded in the following table:

Diameter of Shaft Feet	Coke charge per cubic feet Cwts.	Standard Coke weight Cwts.
2.624	0.178	0.54
3.116	0.238	1.07
3.28	0.259	1.29
3.51	0.269	1.54
4.1	0.276	2.15

Values are plotted in Figs. 86 and 87. Only a fixed amount of iron can be melted and superheated with the standard coke weight. Iron for heavy and medium weight machinery castings can be melted with 8 to 9 per cent coke without any difficulty, whereas light and thin-walled castings demand 10 to 12 per cent.

Depth of the furnace well in practice is measured as the distance from the hearth bottom to the lower edge of the slag hole. The slag hole itself usually is arranged from 5 to 10 inches below the level of the bottom tuyeres and should be located below a point midway between two tuyeres. This arrangements prevents the blast from cooling the slag. Depth of the well largely is determined by the quantity of iron to be collected and the hourly melting capacity of the cupola. Minimum depth is desirable in cupolas fitted with a forehearth or where the tap hole is maintained open constantly. A deep well increases the difficulty of maintaining hot metal.

Temperature attained in cupola melting has aroused some discussion and interest among foundrymen. Experimental determination of temperature at different levels in the cupola has been attempted on many occasions. Belden, in 1913, came to the conclusion that all these attempts failed. Use of platinum-rhodium thermocouples failed through the fracture of the couples due to the weight of the moving charges. At a level 6 inches above the top of the tuyeres the fireclay protecting tubes and fireclay ends on water-cooled tubes melted rapidly. This gives some indication of the high temperature in these zones. The maximum single result of temperature obtained by Belden at this plane was 3083 degrees Fahr. (approximately 1700 degrees Cent.). This result was obtained through an optical pyrometer. Results obtained by Piwowarsky and Meyer by a similar type of pyrometer are plotted diagrammatically in Fig. 85.

Extrapolation of this curve to the tuyere level indicates temperatures of at least 1700 degrees Cent. and under these conditions the maximum tapping temperature of the metal never exceeded 1445 degrees Cent. There is no *a priori* reason to expect the tapping temperature to be equal to the maximum temperature obtained in the cupola stack. In fact there is every reason to expect the tapping temperature of the metal to be lower than this. Rawlinson states that the temperature of the metal at the tapping spout varies from 1250 to 1355 degrees Cent. He doubts if the temperature ever rises much over 1400 degrees Cent.

Gives Entertainment

The Detroit Foundrymen's association held its annual ladies night and dinner dance at the Cadillac Athletic club, First and Lafayette streets, Detroit, on Feb. 21. The affair was well attended.

Publishes Specifications

Proposed specifications for foundry coke, foundry facing, carbon electrodes, and silica mold wash recently have been published by the federal specifications board, Washington. The proposed specifications for foundry coke cover three grades designated as *A*, *B* and *C*. The first is for cupola use and the other two for general foundry heating. The proposed specification for silica mold wash covers two grades, one of which 100 per cent will pass through a 200-mesh sieve, and the other 100 per cent through a 100-mesh sieve. Five grades of foundry facings are covered in the proposed specification for foundry facing. These range from Grade *A* Ceylon graphite to Grade E, a bituminous sea coal facing. The specifications for amorphous carbon electrodes cover data on electrodes from 8 to 24 inches in diameter and from 60 to 90 inches in length. Copies of these proposed specifications may be obtained from the federal specifications board, Washington, and the board would be glad to receive any comments, suggestions or criticisms relating to the specifications.

Table XV

Ratio of Tuyeres Blast Main and Wind Belt

Cupola Diameter	Tuyere area	Blast main diameter	Blast main area	Wind belt area	Ratio
32 inches	149 sq. in.	10½ inches	86	261	3:1
36 inches	180 sq. in.	12 inches	113	336	3:1
44 inches	.....	13½ inches	143	389	2.7:1

M. A. Gordy has been appointed southeastern representative for the United States Electrical Tool Co., Cincinnati, O. Mr. Gordy's headquarters will be in the Norris building, Peachtree street, Atlanta, Ga.

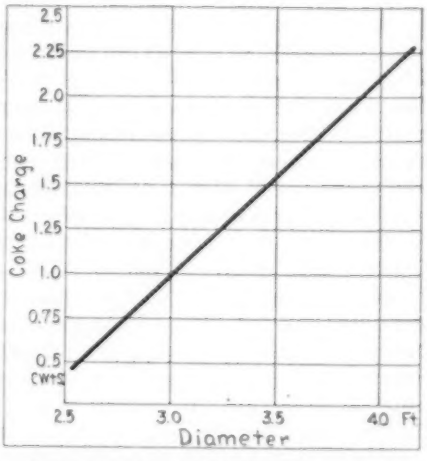


FIG. 87—COKE CHARGE BASED ON DIAMETER

Readers Comment

Note—Material appearing under this head does not necessarily reflect the opinion of THE FOUNDRY or of its editors.

TO THE EDITORS:

I have been interested greatly in the excellent reviews of Continental melting methods and analyses as written by Edward E. Marbaker and published in the Aug. 1 and 15, and the Dec. 1 and 15, 1928, and Jan. 1, 1929, issues of THE FOUNDRY. Tables II and IV as published in the Jan. 1 issue as well as to certain other portions of the other articles, might allow American plant managers and engineers to conclude quite readily that semisteels as produced in the cupola are inferior materials. Even those containing 37.5 per cent steel will not safely pass the tentative American Society for Testing Materials specification for high test cast iron (33,000 pounds per square inch). The figures 26,500 to 33,770 pounds per square inch for the foreign cupola steel-mix irons certainly do not represent better American metallurgical practice, and the implication that these foreign processes must be used in production of better grades of iron is erroneous.

With reasonable technical control, highly machinable grades of iron for small castings are produced with an average tensile strength of 25,000 pounds per square inch and a modulus of rupture of 48,000 pounds per square inch. In small sections, say 0.25-inch, to which such metal is well adapted, the modulus of rupture will exceed 75,000 pounds per square inch. Irons of moderate steel additions, about 15 per cent, easily can be made to average 30,000 pounds per square inch with a modulus of over 58,000 pounds per square inch in the American Foundrymen's association bar. Irons of 25 to 30 per cent steel additions, with reasonably high silicon, are produced readily with tensile strengths from 36,000 to 40,000 pounds per square inch, with a modulus of over 70,000 pounds per square inch in the American Foundrymen's association bar. With high steel and alloy additions, or by other typical American processes, irons between 50,000 and 60,000 pounds per square inch tensile strength have been produced with ease. All these processes are simple and practical for foundry use and are adapted to American production metods. In experimental work the writer has obtained 72,000 pounds per square inch tensile strength.

As a matter of fact, nearly all the foreign practices and theories had their start in the United States. The Rodman process — utilizing heated molds for production of high grade cast-iron cannons, came out, I believe, about 1847. The importance and practical effect of carbon content was pointed out by H. M. Howe many years ago. A Sauveur, in 1912 pointed out that to possess maximum strength (1) cast iron should be of eutectic composition; (2) the eutectic structure should be produced by high silicon and low carbon; (3) the metal should have a eutectoid matrix, which he says can be best produced by high silicon and quick cooling. This is in line with most modern thought about eutectic irons, and with a few slight modifications, covers all we know today. Superheating first was utilized commercially by G. K. Elliott. These and other developments show that as in other lines, American ingenuity and invention have not been lagging. However, the foundry industry as a whole has not been ready to adapt itself to technical control or to encourage research. These are two of the several reasons why the profits of the industry have not been all they might have been.

J. W. BOLTON.

Lunkenheimer Co.

Cincinnati.

Cleaner Foundries Needed

TO THE EDITORS:

The article on ventilation in a recent issue of THE FOUNDRY is exceedingly interesting. More interesting to me than the article itself is the fact that the subject has been brought up. In my mind, sanitation and ventilation are by far the biggest problems. When these problems have been solved, the industry will attract the type of men who will make short business of all of the other problems.

I recently saw the following quotation from Henry Ford in a soap advertisement:

> "Because they are unnecessarily dirty, certain industries now are compelled to get along with low grade labor. Let them clean up and they will find that they can command the services of men who are twice as intelligent and twice as productive."

The foundry can never be made to look like a bank lobby, but I think the majority of foundries, in spite of improvements in this direction, are still guilty of that word "unnecessarily" in the quotation.

C. J. FREUND

The Falk Corp., Milwaukee.

Gives Experience with High Phosphorus Iron

TO THE EDITORS:

Papers and discussions on phosphorus in cast iron which have appeared in THE FOUNDRY from time to time, remind me of an experience which seems to contradict the usual opinion that high phosphorus content is detrimental. While in charge of a large Canadian foundry in 1905 I had a choice of four pig irons, one from Scotland, one from England and two from Canadian furnaces. The analysis of Canadian irons practically is the same as northern pig of the same grade in the United States.

Analysis of the Scottish iron known as *No. 3 Summerlee* follows: Silicon 2.60 per cent, sulphur 0.03 per cent, phosphorus 0.82 per cent, manganese 0.90 per cent, graphitic carbon 3.03 and combined carbon 0.25 per cent.

The English iron known as *No. 3 Clarence* showed an exceedingly high phosphorus content. A typical analysis of the iron follows: Silicon 2.80 per cent, sulphur 0.03 per cent, phosphorus 1.57 per cent, manganese 0.60 per cent, graphitic carbon 3.05 and combined carbon 0.30 per cent.

Owing to the favorable price of the English iron, my principals favored the use of large quantities, but my early training along the usual lines led me to view this high phosphorus iron suspiciously. I used it sparingly in some coal cutter cylinders which later developed spongy areas in thick sections, and leaked.

Some time before I had read an account of some locomotive cylinders cast in a British foundry. The phosphorus content of the iron was given as 1.20 per cent and the claim was made that the cylinders outlasted any others made in that shop.

After trying in several ways to check the trouble, but without success, I determined to try a generous dose (35 per cent) of this high phosphorus iron in the mixture. The castings machined easily and showed as high a tensile strength as castings made from iron with a much lower phosphorus content. We broke one of the castings for a thorough examination and found a close, uniform grain in both thick and thin sections. Apparently English pig iron contains something that is not brought out by analysis. Castings made from English iron mixtures and similar castings made from our northern irons, although conforming to the same analyses, will not show the same physical characteristics.

J. F. GAFFNEY,

Toledo, O.

METALLURGICAL PROBLEMS

Feature A. I. M. E. Meeting

Engineers Discuss Developments in Both the Ferrous and Nonferrous Fields During Annual Meeting in New York

MANY different topics of interest to foundrymen were presented at the annual meeting of the American Institute of Mining and Metallurgical Engineers held at New York, Feb. 18 to 22. These included papers by O. W. Ellis on "High-Strength Brasses;" "Incipent Shrinkage in Some Nonferrous Alloys" by J. W. Bolton and S. A. Wiegand; "Metallic Electrodes for Cast Iron Arc Welding" by Shun-ichi Satoh and "Resistance of Iron-Nickel-Chromium Alloys to Corrosion by Acids," by N. B. Pilling and D. E. Ackerman.

Symposiums and round table discussions featured the meetings which again established a record in point of attendance. Plant visitations, an extensive social program and the unveiling of a bronze bust of Herbert Hoover also were features of the convention.

Frederick W. Bradley, president, Bunker Hill & Sullivan Mining & Concentration Co., San Francisco, was elected president. The following vice presidents were elected: Edgar Rickard, New York; Henry A. Buehler, state geologist, Rolla, Mont.; F. Julius Fohs, consulting geologist, New York; Henry Krumb, consulting mining engineer, Salt Lake City, Utah; George D. Barron, Rye, N. Y.; William H. Basset, American Brass Co., Waterbury, Conn.

Further investigation in the matter of so-called bad iron was reported in a paper by C. H. Herty Jr., physical chemist, bureau of mines, and J. M. Gaines Jr., assistant physical chemist, Pittsburgh experiment station. The paper was presented by Mr. Gaines on the opening day of the meeting. The work of those investigations linked unreduced material in pig iron with irregular operation of the blast furnace. It demonstrated that the highest percentages of silicates are met at times when the furnace is working irregularly. A comparatively rapid change in hearth temperature or an increase in the rate of stock descent, such a slip, will cause a sharp increase in the silicate content of the iron, and the effect of this is carried over to the iron castings or the steel produced from the pig iron.

A technical session on the structure of iron developed considerable theoretical discussion as to whether that still mythical substance, pure iron, would develop the gamma-alpha transformation. Dr. T. D. Yensen, research laboratory, Westinghouse Electric & Mfg. Co., East Pittsburgh, presented a paper on pure iron and allotropic transformations in which he developed the hypothesis that pure iron has no allotropic transformation below the melting point.

Discusses Pure Iron

The paper on the gamma-alpha transformation in pure iron by Albert Sauveur, professor of metallurgy and metallography, Harvard university, Cambridge, and C. H. Chou, National Tube Co., Lorain, O., was read by the former. These two papers were discussed by A. B. Kinzel, metallurgist, Union Carbide & Carbon research laboratories, Long Island City, N. Y., H. W. Gillett, chief, division of metallurgy, bureau of standards, Washington, G. B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology, Cambridge, and others.

In the discussion following the paper by N. A. Ziegler, research laboratory, Westinghouse Electric & Mfg. Co., East Pittsburgh, on gases in iron carbon alloys, it was pointed out by several investigators that melting in vacuum was a fairly simple process. It merely requires a hood over an induction type electric furnace with a small vacuum pump attached. High vacuum is not essential it was said.

Interesting research in the field of electric arc welding of cast iron was described in a paper by Shun-ichi Satoh, research staff, Mitsubishi research laboratory, Tokio, Japan, which was presented by Mr. Waterhouse. He described in considerable detail methods of coating an iron bar or electrode with asbestos tape and then coating this with a pasty mixture of graphite and carborundum. When such covered electrodes are connected to the negative pole he was able to deposit with considerable success high grade cast iron. Micrographs of the cast iron thus deposited were shown on the screen. Francis B. Foley, superintendent of research, the Midvale Co., Nicetown, Philadelphia, in commenting on Mr. Satoh's paper said he thought that by increasing the voltage up to nearly 50 volts and by adding still another coating of asbestos and paste even better results could be secured.

Signs of exhaustion are beginning to appear in the production of minerals throughout the world, said D. F. Hewett, geologist, United States geological survey in a paper reviewing metal production. The best efforts of science and technique are being enlisted to keep abreast of the ever increasing demand. The paper pointed out that the once vast resources of iron, copper, lead and zinc have been attacked vigorously under a system based largely on individual initiative and uncontrolled personal profits. Many outstanding districts are becoming depleted and the demand is being met by turning to new sources of lower grade ores. It is a race in which reliance is placed on science and technique.

The plea for engineering standards in the development of our whole social structure was made by George Otis Smith, director of the United States geological survey and retiring president of the American Institute of Mining & Metallurgical engineers at the annual banquet held Wednesday night. In his talk he said in part: "The worker of today with the many rapidly revolving wheels at his command can do more work in a short time than scores if not hundreds of his ancestors could do working from dawn to dark. An engineer today frequently travels more miles in a month than his grandfather did in a lifetime. All this progress in industry, transportation and communication is an exhibit of what engineering by the application of science has wrought. We need to

realize that high speed living involves fast spending and that the acceleration which has characterized recent years cannot long continue without some check. The national engineerings societies have become in a sense public utilities. With his habit of facing the facts the engineer can both promote and protect social progress.

Change Sub-Committee

In a report of the iron and steel division presented on Wednesday the organization of new committees and the progress of the division through the year was outlined. The former sub-committee on foundry has been split into two committees, one on steel foundry and the other on iron foundry. Zay Jeffries, consultant, Aluminum Co. of America, Cleveland, was selected to deliver the Howe lecture in 1930. George B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass., was elected chairman of the iron and steel division for the ensuing year. Richard Moldenke, metallurgist, Watchung, N. J., was elected one of the new vice chairmen of this division.

On Wednesday a general session of the institute of metals division was held under the chairmanship of W. B. Price. Several papers were presented including those of W. C. Ellis and E. E. Schumacher on heat treatment and mechanical properties of brass and bronze containing nickel. The authors found that the mechanical properties can be varied over a wide range by suitable heat treatment. "High Strength Brasses" by O. W. Ellis presented the results of an investigation on the effects of aluminum, iron, manganese and tin on the mechanical properties of alpha-beta and beta brass.

J. W. Bolton and S. A. Weigand in their paper on "Incipient Shrinkage in Some Nonferrous Alloys" stated that internal porosity, commonly called oxidation, usually is traceable to incipient shrinkage. This is pronounced in metals melted under reducing atmospheres. Incipient shrinkage may be minimized by running in a neutral atmosphere maintained by gas analysis and not by eye, by proper gating and reasonable pouring temperatures. "Equilibrium Relations in Aluminum-Magnesium Alloys of High Purity," by E. H. Dix Jr. and F. Keller, presented the results of an investigation to determine the true equilibrium phases using pure materials.

Among the papers presented at the all-day symposium on corrosion of the institute of metals division held on Thusday are those of D. J. McAdam Jr., on the "Corrosion of Metals as Affected by Stress, Time and Number of Cycles"; "Corrosion of Tin and Its Alloys," by C. L. Mantell; "Inhibition of the Corrosion of Aluminum by Soaps," by H. V. Churchill; "Correlation of Laboratory Corrosion Tests With Service," by H. S. Rawdon; "Resistance of Copper-Silicon-Manganese Alloys to Corrosion by Acids," by H. A. Bedworth; "Resistance of Iron-Nickel-Chromium Alloys to Corrosion by Acids," by N. B. Pilling and D. E. Ackerman; and "Some New Developments in Acid-Resistant Alloys," by B. E. Field.

Dr. Ulick R. Evans, of Cambridge university, Cambridge, England, presented the annual institute of metals lecture and chose for his subject "The Passivity of Metals, and Its Relation to Problems of Corrosion." He said in part: "If a strip of iron is heated strongly at one end, the other end remaining cold, there is produced over the heated portion a layer of oxide scale the thickness of which diminishes steadily with the distance from the hot end." With this as a starting point he developed many theories and described exhaustive research in the field of corrosion.

Collects Data on Tonnage of Castings Poured

Eleven foundries in Worcester, Mass., have entered into an agreement whereby the total monthly tonnage of castings for the group will be published through the foundry council of the chamber of commerce. These figures are expected to furnish an important barometer of business conditions. The record for 1928 is as follows:

	Pounds
January	2,914,072
February	3,344,557
March	3,766,107
April	3,504,179
May	3,683,065
June	3,439,880
July	3,465,559
August	3,181,115
September	3,110,968
October	3,709,744
November	3,981,883
December	4,175,119
Total	42,276,248

The 11 foundries in the agreement and the representatives on the council are as follows:

Arcade Malleable Iron Co., Henry P. Blumenauer, chairman of the council; Framingham Foundries Inc., Framingham, Charles Burkhart; Holyoke Machine Co., John D. Stanley; Jackson St. Foundry Co., William O. O'Neil; Milford Iron Foundry, Milford, Harry L. Welch; L. W. Pond Machine & Iron Co., Patrick T. McDonough; R. P. Power Foundry Co., Richard P. Power; Reed-Prentice Corp., James J. Higgins; Standard Foundry Co., George F. Hutchins; Washburn Shops, Worcester Polytechnic institute, Burton L. Gray; Worcester Foundry Co., Thomas J. Finn.

Officers Are Elected

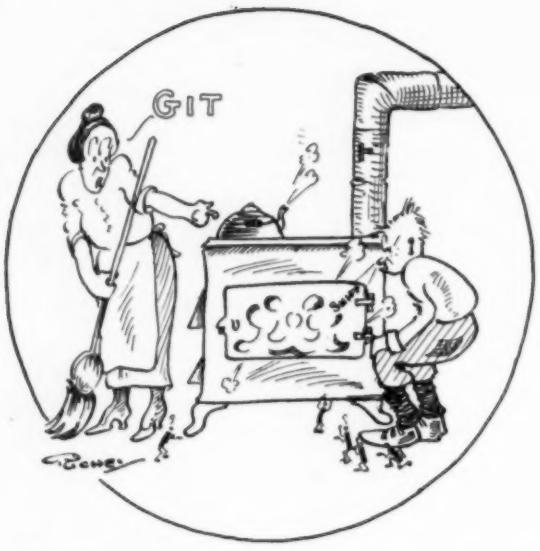
E. H. Swindell & Bros., Pittsburgh, makers of electric and heat treating furnaces, recently elected the following officers: John F. Casey, president; R. W. Porter, vice president; C. E. Lott, secretary; W. H. Cosgrove, treasurer and F. W. Brooke, chief engineer. Mr. Cosgrove succeeds E. H. Swindell, deceased, as treasurer, and Mr. Brooke has succeeded Mr. Cosgrove as chief engineer.

Buys New Plant

Swartwout Co., Cleveland, with plants at Fostoria and Orrville, O., has purchased the plant formerly owned by the Cleveland Milling Machine Co., 18511 Euclid avenue, Cleveland, for $225,000, where the operations of the company will be moved from its other factories. This firm makes ventilator and regulator equipment. The new plant has 90,000 square feet of floor space and occupies 7 acres of land at Euclid avenue and the Nickel Plate railroad. Operations of the S-C Regulator Co., recently purchased by Swartwout Co. already have been moved to Cleveland from Fostoria, O., and the Orrville, O., unit of the Swartwout Co. will be transferred within the next six or seven months.

Installs Equipment

R. W. McIlvaine Co., Chicago, has completed the installation of a continuous molding system for the Hamilton, Ont., plant of the International Harvester Co. Complete sand handling equipment, power mold and gravity conveyor systems were installed. The power mold conveyor system is for heavier classes of work, such as mower frames and mower wheels. The gravity conveyor will handle intermediate work of a miscellaneous nature, and a light mold conveyor system will handle smaller work on a production basis. The McIlvaine company also is installing sand handling equipment and two heavy power mold conveyor systems at the Rock Island, Ill., plant of the International Harvester Co.



Bill Diagnoses a Leak in a Pipe Casting

By Pat Dwyer

OVER a month has elapsed since I read the obituary notice of a famous citizen. Up to the present I have not learned of any movement to erect a suitable national monument to his memory, some tangible appreciation of his noble efforts to add to the happiness of mankind. Millions of men and boys in this and foreign countries have reason to regard him with the kindliest feeling of respect and admiration.

Monuments have been erected to many less deserving human beings. In many instances a misguided public has glorified men in enduring bronze or marble, men, who to further their own petty ambition and lust for power, sacrificed multitudes of their fellowmen. Instead of commemorating their wickedness in monumental form, these lads should have been stuck on the end of a fork and dipped into a pot of iron like a doughnut in a pan of sizzling grease. A few of the resulting blocks of iron suitably inscribed and set up at strategic points here and there in the countryside would do more for the peace and prosperity of the world than 40 peace treaties or leagues of nations.

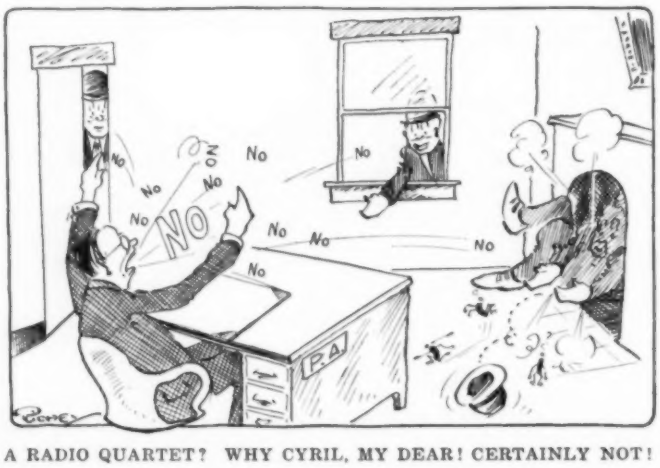
This man to whom I referred originally and who lately slipped away to the port of missing men, was in a distinctly different class. He disseminated peace and comfort. He placed luxury within the grasp of the humble. He helped men to endure misfortune, hunger and privation. He comforted them in misery and added to their happiness in times of prosperity. In the lonely watches of the night and in crowded communities, by day and night, on the road at work and play, at home and abroad, under practically any and every condition he was, in the language of the day, right there with the goods. Who was this noble benefactor, this solace for the weary, this rock in a weary land, this shelter in a time of storm? Hold everything, men! He was the inventor of the greatest boon to the human race since Walter Raleigh carried the divine weed to England. He was the man who invented and perfected the ubiquitous Missouri meerchaum, the well-known corncob pipe!

If I had the wings of an eagle, which merely is a fanciful way of saying if I was gifted with the ability to soar away on the wings of song, I should chant a noble paen in praise of the many virtues possessed by this humble tool, utensil or device. In its delicate and virgin purity, the smooth and shining exterior of a new pipe rivals the satiny texture and shade of daffodils nodding their heads in the breeze with the shy and demure pride of so many young maidens.

The interior is as clean and antiseptic as the operating room in a hospital, the well-known, if slightly overworked hound's tooth, or the old brown bowl in which your mother, with an uncanny skill never equalled by the ancient alchemists, mixed the heavenly combinations which caused your little grimy and snubby nose to wrinkle in delightful anticipation. You can travel to the wide world's rim and never find a smell to equal the aroma from the old kitchen oven—except perhaps the long aromatic, curling wreaths from a corncob pipe filled with black tobacco.

Where will you find a stem to fit the teeth so neatly, comfortably and sweetly as the light and delicate reed, tapered slightly at one end to form a perfectly airtight fit with the bottom of the fire pot? The stem adjusts itself automatically to any molar formation, the sharp dog teeth of ambitious youth, the strong square teeth of lusty manhood or the worn snags of old age. Toothless dotards of either sex to whom first hand enjoyment of tobacco is impossible through inability to grip the stem of any other species of pipe, find no trouble in gumming the stem of a feather-light corncob.

For initial capital investment, upkeep, maintenance and repair, and ease of operation, no other type of pipe can compare with the lowly cob. A nickel, the twentieth part of a dollar, will be accepted in exchange for a perfect specimen at any of the smoker's havens of refuge throughout this broad land. This refers to the pure and unadulterated article in all its pristine simplicity and beauty and is not to be confused with the misbegotten hybrid, carrying a bone tip on the end of the stem and which, ostensibly for that reason, retails for a dime. To the true and discriminating smoker, the bone tip is as welcome as a worm in an apple, or chlorine in the water. It converts an otherwise soothing and aromatic stream of smoke into a reek comparable to that from a fire on the city dump with a dreary wind blowing from the northeast. A certain lady has complained bitterly on many occasions that my pet tobacco smells even worse



A RADIO QUARTET? WHY CYRIL, MY DEAR! CERTAINLY NOT!

than that, irrespective of what kind of a pipe I smoke. Manifestly, since she is a confirmed nonsmoker, her opinion may be disregarded or brushed lightly to one side as of no importance.

I am sufficiently broad-minded to accept expert opinion on any subject, but certainly a person who never has smoked a pipe is in no position to pose as an expert smoke smeller. Her invariable reply to this apparently logical and airtight argument is that she is no hen, but she can differentiate between an egg that is fresh and one that has been knocking around the world for a considerable period. There must be a catch in that thing some place. Some day when I have the necessary time—and inclination—I am going to poke around until I find it. Up to the present, in the interest of peace and so forth, I have contented myself with the rejoinder that a crowing hen never walked off with a popularity prize. Cruel, you may say, but desperate diseases require desperate remedies. The captious critic, one of those pests always looking for an argument, probably will rise at this point to claim that at least in one respect, first cost, the clay pipe, sled runner, bull dog or plain old *T. D.*, holds a premier position. To this I reply, Pooh! Also Bah! Twice if necessary.

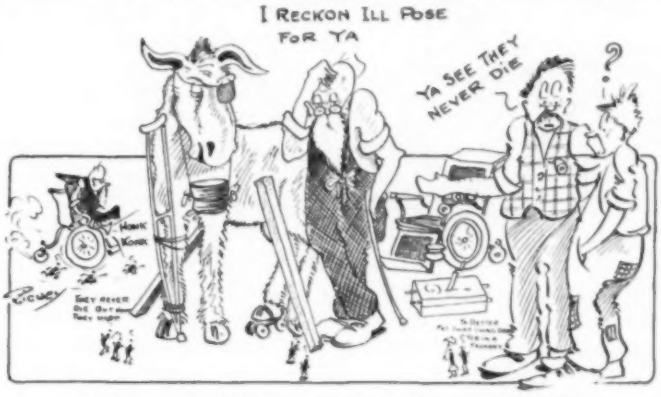
As in raising a family, a dog, or any other of a long list of luxuries, I might enumerate if I had the time, it is not the first cost, but the upkeep that breaks the camel's back. I have not bought a clay pipe for many years. Therefore, at the moment I cannot give the market quotation in broken lots or in carloads f.o.b. (few only broken) but in the so-called gay nineties, when a penny was rated as a coin of the realm, a clay pipe could be secured in exchange for one of these pieces of legal tender.

At one time or another I have known a highly gifted individual who smoked the same clay pipe day in and day out, as the saying goes, for months, but these were notable exceptions. After a few months of constant stoking, one of these pipes became as black as Simon Legree's heart and smelled worse than the hold of a slaver three weeks overdue from the gold coast. Bit by bit, the stem corroded and dropped off until imminent danger of blistering the end of his beak caused the owner reluctantly to throw the precious old relic away.

However, as I said, these constituted an exceedingly small minority. The average life expectancy of a clay pipe was one day. In many instances the owner only enjoyed one smoke before any one of the 1001 accidents to which clay pipes are subject, ruined it beyond repair.

Although never proclaimed publicly, keen students of the English language have discovered that 87.063 per cent of our picturesque and profane vocabulary is directly traceable to the heartfelt and extemporaneous effort of unfortunate gentlemen who confidently reached into pockets for clay pipes and found the stems broken off short at the bowls.

The man who invented the corncob pipe was perfectly familiar with this fiendish propensity of all pipes to break at the one and only point that rendered them useless. Instead of wasting his time in developing a kit of tools and a suitable adhesive for repairing the damage, he attacked the problem from another and more logical angle.



FROM THE FAMOUS PAINTING *NEVER SAY DIE*

"No power on earth," he said to himself, "can prevent a pipe from breaking. What the people of this country need," he said, "is a pipe that will break, but not permanently. A pipe that will withstand the slings and arrows of outraged fortune and so forth, and still come up smiling."

A true philanthropist, if ever there was one, he buckled down to the job with a right good will, and the result, as all the world knows, is the two-part corncob pipe.

At home or abroad, in shop or office, by flood or field, the owner always can depend on the old reliable. In many respects it resembles another famous product of Old Missourah, the long-eared, faithful, hee-haw personification of endurance, integrity and frugality, the mule. In compensation for the unfortunate bar sinister on his escutcheon, this noble animal is immune to all the ills which afflict his aristocratic father or mother—I am a little hazy on the exact relationship—and can out work, out last and out live any haughty horse that ever walked on four feet. Like a goat, he can live on nothing or next to nothing. He can eat one meal a day or ten and if his owner can't feed him, he can forage for himself. At the end of a long day's grind, the horses in the caravan drop exhausted, too tired to eat. The frisky mule, freed of his harness and seeking innocent diversion, stages a free-for-all, knock-down and drag-out shindy with any opponent, human or animal in the vicinity. He never is sick, never is tired. There is a tradition to the effect that he never sleeps, and I have heard—but this I am inclined to doubt—that he never dies. One of my reasons for doubting the statement is on account of the manner in which the molding fraternity is dragged into it and subjected to gross slander. Even if the words *mule* and *molder* commence with the same letter, that is not sufficient justification for coupling the names together and hanging the owners of the names on the same hook in the museum. I experienced the first of many shocks in my apprentice days when I heard an old hairy molder grinningly declare that no person ever saw a dead mule or a dead molder. To my eager and innocent request for further light on this remarkable phenomenon he assured me solemnly that they just disappeared.

At that time I never had seen a mule. Therefore, I was in the position of the child who first hears about Santa Claus. A bright, handsome young lad—take it or leave it—I believed the old pagan was lieing, but as St. Paul says in one of his numerous epistles to the great unwashed—I quote colloquially from memory—*Faith without evidence is all wet.*

Later, over a period of many years and a fairly wide acquaintanceship with knights of the rammer and shovel I discovered that the statement was at least 50 per cent innacurate. Up to the present my association with mules has not been sufficiently intimate to collect any reliable statistics, but as I said before, I entertain a reasonable doubt. Recently I asked Bill's opinion on the subject.

"Well," said Bill, "I'll tell you. Mules are like purchasing agents. No one knows what they will do, or won't do. Have you ever read Elbert Hubbard's description of a purchasing agent? Listen while I read it to you."

The typical purchasing agent is a man past middle life, spare,

wrinkled, intelligent, cold, passive, noncommital; with eyes like those of a codfish, polite in contact, but at the same time unresponsive, cool, calm and as damnably composed as a concrete post or a plaster-of-paris cast. A human petrification with a heart of feldspar and without charm or friendly germ, minus bowels, compassion or a sense of humor. Happily, they never reproduce and all of them go to hell.

"The Fra," I said, "must have had some of his stuff refused the day he wrote that bitter comment. The purchasing agent's job is no sinecure in these strenuous days with the country overrun by a horde of high pressure salesmen. He has to defend himself and I want to hear his side of the story before I accept this crabby description."

"Well," Bill admitted, "there may be something in that. He may have his own troubles. In fact, we all have 'em and have had 'em since the days of Adam. I had an inquiry the other day from a foundryman who was having trouble with some pipe fittings. He makes special pipe castings which are subjected to an air pressure test of 40 pounds per square inch. He has little or no trouble on castings up to 12 inches diameter, but on the 16-inch and larger sizes he finds porous spots, usually in the vicinity of the junction between the body and the bell end. He finds no blowholes, slag or dirt inclusions in the defective area. His cupola charges are made up of No. 1 machinery scrap and low silicon pig iron. He does not add steel to the charge, but occasionally employs a little ferromanganese. Typical analysis of the iron in the castings shows: Silicon 2.00 per cent, sulphur 0.09 per cent, phosphorus 0.66 per cent, manganese 0.42 per cent.

"From the description it is apparent that his molding, melting and coremaking practice are all that they should be with one slight exception. This slight exception is responsible for the leak and may lie in any one of the three foregoing departments. A detailed checkup on everything entering into the production of one or two castings will show him what is wrong.

"At this distance and basing my opinion entirely on the evidence submitted, I am inclined to the opinion that the cores are responsible for the leaks in the castings. Either on account of the manner in which they are made, or because of the character of the sand or quantity of binder, the core does not allow the iron to lie quietly against it. A slight boiling action is set up, not enough to show as permanent blowholes or blisters, but sufficient to cause porosity. I assume that he is using dry sand cores, made in the usual manner by pasting two halves together.

"Instead of making up a solid block of sand with perhaps a 1-inch diameter vent scratched in the joint, he should fill the interior with coke or cinders. A core made in this way will dry quickly and thoroughly, will allow free exit of the gas during the pouring period and will not cause the iron to bubble in contact with it. All he needs is a shell of sand about 2 inches thick. He may be using too much binder, thus producing a beautiful hard core from the coremaker's standpoint, but a core in which the interstices of the sand are choked, thus preventing escape of the gas. He should cut the amount of binder down to a point that will enable the core to be handled with proper cars.

TRANSVERSE STRENGTH SEEMS WELL ABOVE THE AVERAGE

"On the former assumption that the core is a solid lump of sand, the possibility exists that it has not been dried thoroughly. Heat from the molten iron has penetrated to a point where latent moisture has been converted into steam and the steam in turn has traveled upward instead of trying to penetrate the dense mass of sand in the center of the core.

"Many foundrymen *top* the special pipe fitting cores with green sand. This expedient saves time, sand, binder, oven space in the core room, and subsequent time in the cleaning room. The lower half of the core is made and dried in the usual manner. The second half is made in green sand, either in the same half core box, if it is reversible, or in a second half box, in the event that two half coreboxes are required to form the complete core. The green sand half of the core is partly filled with coke or cinders, and a suitable iron or wood standard placed in the print to hold the completed core down in the mold. In special instances the lower half of the core is provided with a suitable iron or sand projection by which it may be anchored to the bottom board or plate, or blocked down from a weight, or from the cutout end of the cope. In practice a slight amount of paste is daubed on the joint of the green sand while still in the half corebox. The dry sand half then is matched on top of it and the entire assembly is rolled over. The half corebox is removed and the completed core is placed in the mold. On large size cores it is advisable to brush a light coating of blacking or plumbago on the green sand. His trouble may be due partly, to a low pouring head. If the cope is shallow to save sand, he should build up a pouring head and riser. The extra pressure obtained in this manner frequently is sufficient to overcome an incipient tendency toward sponginess and shrinkage. A remote possibility exists that the trouble may be traceable to the mold. The sand may be too tight, or rammed too hard, particularly around the neck of the casting. The sand may contain more moisture than necessary, or the bottom board may be jammed on the flask in a manner to prevent all escape of gas and steam in that direction. In fact any one of a long list of minor details may be responsible for the defect in the casting, but I suggested a careful scrutiny of the coremaking practice before investigating any of the other possibilities.

Study Oxygen Estimation

Recently the bureau of standards published a bulletin on a method of using hydrogen, antimony and tin for the determination of oxygen in cast iron. The method was compared with the vacuum fusion method and within the precision of the method, about 0.006 per cent oxygen, the hydrogen reduction process gave the same values as the vacuum method. Precision of the latter method makes it preferable. This bulletin is Research Paper No. 25 and may be obtained from the superintendent of documents, government printing office, Washington, for 5 cents.

Heap Sand Causes Trouble

Advantages of Using a Satisfactory Facing Sand Mixture Is Nullified at Times by the Use of a Heap Sand Lacking Bond and Permeability in Proper Proportion

By H. T. Preston

DUE to the rapidity with which the metal solidifies and the high temperatures required, heap sand in the steel foundry plays as important a part as the carefully tested and mixed facing sands. Sand control is in its infancy and much work remains to be done in this new field. Interest is becoming more general and many foundrymen now are warm advocates of careful control. They are looking for practical information that may be applied in everyday practice and not a presentation of technical terms.

Sand heaps in the majority of steel foundries are kept up by the daily addition of facing from the shake-out. In many cases thought is not given to the amount of fines continuously increasing, or the amount of bond that the heap contains. Many foundrymen would be surprised if they analyzed their heaps and learned how much fine material and bond the sand contains.

Some foundrymen spend time and money to develop strong and open facing mixtures, and then wonder why the castings are blown and scabby. Analysis of the backing sand would show a permeability number lower than a highly bonded sand for gray iron. They may have trouble with sand falling out of the backs of dry sand molds. The sand seems strong enough in the green state, but will not hold up after it is dried.

Water additions to a weak heap will confer a *false bond*, but when the sand is subjected to heat in the drying oven it is left practically dead and a large amount will drop out in handling the molds. With heads and gates made from this sand it is no wonder so many castings are scrapped on account of sand inclusions, usually on the cope side. This is a feature of the utmost importance to foundries producing castings designed to withstand pressure.

Why not ram gates and heads in facing sand? That would be the logical procedure but several reasons interfere. Some patterns, due to design, make it necessary to build the gates and heads by hand if facing sand is to be used for that purpose.

If the molding machine operator in a production shop had to face the gates and heads he could not earn a day's wages. If the piece work rate is increased, the cost of the job will be out of reason. The only possible and logical remedy is to use a heap sand that will stand up during the entire process from beginning to end.

How is one to know in advance the condition of the heap? What is the remedy for this condition? Valuable information regarding the character of the sand may be obtained by daily tests for moisture, permeability and strength. Since the strength and permeability are dependent upon the fineness and bond, a weekly test is advisable for ascertaining percentage of bond and fineness. In relation to these tests one should also observe the condition of the molds after they are dried. Based on a technical and practical viewpoint one can establish a standard to which the heap sand should conform.

Take Daily Tests

Additions of fire clay constitute a remedy for weak sand. These additions will depend upon the character of the sand. In foundries where the sand is under control, a daily addition of ½ to 1 per cent is sufficient to keep up the strength. A high refractory and plastic clay, low in silica content is desirable. Just enough of this clay should be cut into the heap to strengthen the sand to a point where it will stand the handling of the molds and flow of metal in the gates. Often trouble is experienced on account of weak sand in the heads. Many times this will result in spalling around the heads, causing sand to drop. This sand will be found in the metal after the casting is cleaned.

A heap sand low in active bond necessitates the use of excess moisture to secure cohesiveness. This results in several bad conditions. Wet sand will shift under the rammer. It loses its cohesiveness when dried. It retards drying of the mold, and causes excess gas in green sand molds.

Why the necessity of high permeability in heap sand? The generally accepted idea is that facing sand will take care of any gas generated in the mold. According to reports, one cubic inch of sand will give off 30 cubic inches of water vapor for each per cent of moisture contained. The average moisture content for steel molding sand is 4 per cent. This gives 120 cubic inches of water vapor for each cubic inch of sand close to the metal, and a corresponding amount in the sand further back. It is easy to see that adequate provision must be provided for escape of this gas.

Assume a facing sand with high permeability and a backing sand with a low permeability. How will the large volume of steam escape quickly after it passes 2 or 3 inches of facing sand? Without doubt some of it will seep through the backing, but unless the remainder can find some quick avenue of escape, it is bound to follow the path of least resistance through the facing sand and thence into the metal. Action takes place in such a short time that the metal still is in the molten state. If the pressure of steam and mold gases is high enough, portions of the mold face will be blown off and carried into the metal.

The small foundry may open the heaps by cutting-in a quantity of good round grained, washed sand of suitable grain size. This will relieve the situation somewhat, although the process must be repeated at intervals. The amount of fines will increase continually due to the fine silica grains in the fire clay.

Some relief may be had by using a more open new sand. This is a rather slow method. Some time is required for this new sand to work through the entire system.

An exhaust system probably is the most practical for the large foundry. If the heap sand is run through an exhauster occasionally and a large quantity of dust and fines removed, an open sand can be obtained. In either large or small foundry it will be necessary at intervals to add a small amount of high plastic clay to the heaps to give additional bonding

properties; to take the place of binder removed by the exhaust; or, on account of the absence of clay in the new sand.

In many foundries the heaps are not cut properly. Unless the heap sand is milled in a pan mill, or some other device, to thoroughly distribute and rub in the clay additions, considerable time will be required to get maximum results. Where a sand cutter is employed it should go through the heaps as many times as possible when preparing the day's supply of sand. This will aerate the sand and result in higher permeability, higher strength and uniformity. The molder easily can do better work. Condition in which the heap sand is kept is reflected in marked degree in the appearance of the castings produced.

Sand control and reclaiming methods offer a splendid opportunity to know the condition of the heap sand. With this knowledge the foundryman can obtain maximum results with his reclaiming equipment.

One important feature to be observed in any sand control program is the necessity of securing co-operation from both technical and practical men. Loose connection causes friction between departments while co-operation between the shop and laboratory will accomplish wonders. The laboratory may decide how to overcome difficulty existing in the shop, but sometimes difficulties arise when attempt is made to put a new idea into practice. The laboratory man may have definite paper proof for his theory, but in the application it does not work always as he expected. Often this is due to conditions known to one department but not to the other.

The human element always is present in the foundry and regardless of how satisfactory sand conditions may be, defective castings may be expected. Many times the sand has been the scape goat for a careless workman. A satisfactory plan in one foundry may not work in another. Each shop must study its own conditions over a reasonable period and then intelligent action may be taken to adjust faulty conditions.

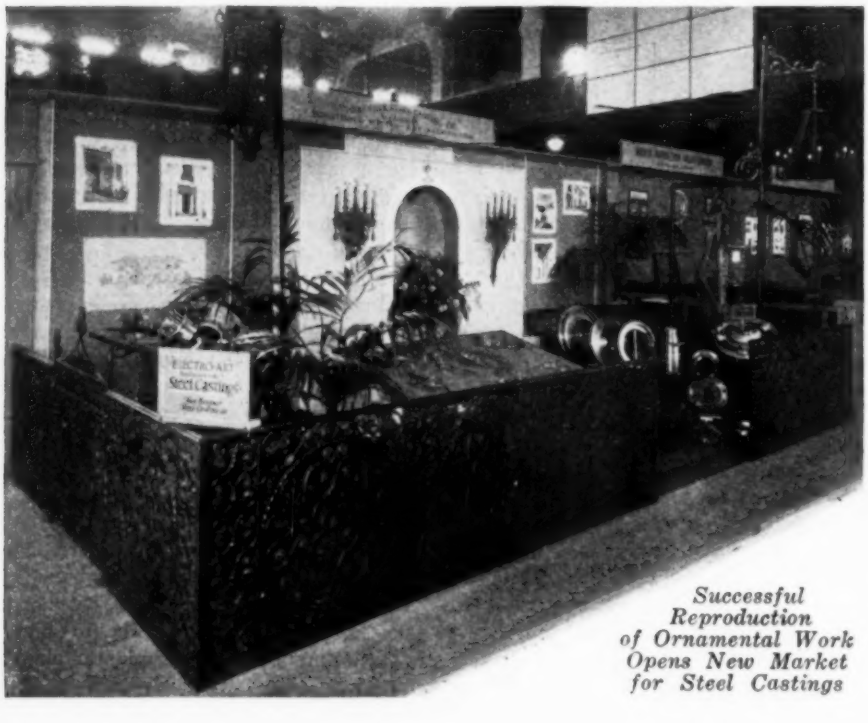
Appointed Sales Manager

Judd W. Spray has been appointed vice president and general sales manager of the Timken Roller Bearing Co., Canton, O. He has been general sales manager of the company since 1926 and prior to that he had been sales manager of the automotive division of the company in Detroit for a period of several years.

Steel Castings Play New Role

ALTHOUGH much has been written concerning the present modernistic trend in design of furniture and decorative features, the better periods of antique design still are much in demand. While a considerable tonnage of bronze and brass castings of artistic craftmanship has been employed for years for lighting fixtures, balcony and stair rails, gates, etc., a return to the use of cast iron for this purpose has been noted, and is described in the March 1, 1928, and March 15, 1928 issues of THE FOUNDRY.

California with its warm, sunny climate and Spanish type of architecture is a large consumer of what commonly is called wrought-iron, ornamental work. An enterprising steel castings manufacturer of Los Angeles, realizing that this material is made not from wrought iron, but fabricated from soft steel, and observing a good market at his own doorstep, believed rightly that what could be fabricated from soft steel could be made as good if not much better in the form of a steel casting.



Successful Reproduction of Ornamental Work Opens New Market for Steel Castings

Using an expression familiar in that part of California—namely *Lights—Action*, the lights already were present, and the action resulted in the development of a method for producing a variety of types of ornamental work in the form of steel castings. The Kay-Brunner Steel Casting Co., Los Angeles, responsible for opening up this new field for steel castings, exhibited a number of its ornamental castings at the Western Metal Trades exhibition which was held in Los Angeles, Jan. 14 to 18.

A reproduction of the firm's booth is shown in the accompanying illustration. This shows several sections of railing wth a gate at the left. Two large lamps and supporting standards, two wall-type candelabra lamp brackets and several smaller intricate ornamental castings.

Pittsburgh Group Meets

S. T. Johnston, president, and C. E. Hoyt, secretary-treasurer of the American Foundrymen's association, were guests of the Pittsburgh Foundrymen's association at the latter's monthly meeting Feb. 18. Other guests included B. J. Fuller, of Cleveland, former president of both the local association and the American Foundrymen's association, and D. M. Avey, editor of THE FOUNDRY, Cleveland. H. M. Crawford, engineer of the industrial department of the General Electric Co., Schenectady, N. Y., gave an illustrated talk on automatic blast gate control for cupolas.

The FOUNDRY Family Photograph Album

Upper Left

JOSEPH HONZE

National Malleable & Steel Casting Co., Chicago

Lower Left

LAIRD U. PARK

Park & Williams Inc., Philadelphia

Upper Right

E. B. GILMOUR

W. B. Huber & Co., Los Angeles

Lower Right

W. OBERHELMAN

Hill & Griffith Co., Birmingham, Ala.

SCRAP METAL SPECIFICATIONS

(*Continued from Data Sheet No. 754*)

Heavy Shoveling Steel Scrap

Heavy, clean, wrought-iron and steel scrap, ¼-inch and over in thickness, not exceeding 8 inches in breadth or length, and no piece to be less than the equivalent of ½-inch square 3 inches long will constitute heavy shoveling steel scrap. May include clean horseshoes, railroad spikes, bolts, nuts, tie-plates, etc., boiler, bridge, and structural punchings and clippings, small bar and shafting crop ends, and other similar material.

To contain no burnt material, cast or malleable scrap, cut pipe and tank, skeleton stock, badly corroded material, or any twisted or tangled scrap. Must be free from foreign metals of all kinds, from galvanized painted, enameled, or other coated stock, and from dirt and rubbish of all kinds.

Must be loaded in separate cars from other grades of scrap.

Alloy steel scrap may be excluded from these specifications by mutual agreement between the buyer and seller.

Short Shoveling Flashings

Flashings or trimmings from iron or steel forgings to be 10 inches or under in length, suitable for hand shoveling, to include no tangled or twisted material will constitute short shoveling flashings. Alloy steel scrap may be excluded from these specifications by mutual agreement between the buyer and seller.

Long Flashings

Flashings or trimmings from iron or steel forgings, which have been separated strictly to a minimum length of 20 inches and not to exceed a maximum of 36 inches will constitute long flashings. There must be a thickness in some section of each of these flashings of not less than 3/16-inch. Alloy steel scrap may be excluded from these specifications by mutual agreement between the buyer and seller.

Mixed Flashings

Flashings or trimmings from iron or steel forgings, not over 36 inches in length will constitute mixed flashings. Alloy steel scrap may be excluded from these specifications by mutual agreement between the buyer and seller.

No. 1 Busheling

Clean iron and soft-steel pipes and flues, tank, cut hoops and bands No. 12 gage and heavier, steel plate punchings and clippings, soft-steel and iron forgings, and flashings, no dimension over 8 inches, will constitute No. 1 busheling. To be free from burnt material, hard steel, cast, malleable, and galvanized or metal coated stock of any kind.

(*Continued on Data Sheet No. 756*)

SCRAP METAL SPECIFICATIONS

(*Continued from Data Sheet No. 755*)

No. 2 Busheling

Cut hoops, netting, cotton ties, sheet, and similar material lighter than No. 2 gage, no dimension over 8 inches, will constitute No. 2 busheling. To be free from hard steel, cast, malleable, and galvanized or metal coated material of any kind.

No. 1 Selected Rail Scrap

Standard section Tee and guard rails, 40 pounds and heavier per yard, not less than 36 inches long, to be free from frog and switch rails not cut apart, and contain no manganese steel scrap or cast welds or attachments of any kind, concrete, dirt, or foreign material of any kind will constitute No. 1 selected rail scrap.

No. 1 Selected Shearing Scrap

Angles from 2 inches up to 8 inches, structural shapes in single members from 4 inches up to 9 inches, bars ½-inch and over up to 4 inches diameter, and flats ½-inch to 2 inches thick and from 1 to 10 inches wide will constitute No. 1 selected shearing scrap. To be in straight lengths and free from dirt and foreign material of any kind. Long length girder rails free from cast welds and attachments may be included by mutual agreement between the buyer and seller.

Axle Turnings

Heavy, short first-cut turnings from wrought iron and steel railroad axles or heavy forgings, and rail chips, to weigh not less than 75 pounds per cubic foot, free from dirt or other foreign material of any kind, will constitute axle turnings. Alloy steel scrap may be excluded from these specifications by mutual agreement between the buyer and seller.

No. 1 Machine Shop Turnings

New, clean steel or wrought-iron turnings, free from lumps, badly tangled or matted material, cast-iron borings, other metals, excessive oil, dirt or foreign material of any kind, will constitute No. 1 machine shop turnings. Badly rusted or corroded stock will not be accepted.

No. 2 Machine Shop Turnings

New, clean steel or wrought-iron turnings, curly, bushy stock which may contain tangled material, but must be free from badly rusted, lumpy and corroded stock, will constitute No. 2 machine shop turnings. To contain no cast-iron borings, other metals, excessive oil, dirt, or foreign material of any kind.

Cast-Iron Borings

New, clean cast-iron borings and drillings, free from steel turnings and from badly corroded or rusty material, lumps, oil, scale, other metals, dirt, or foreign material of any kind.

(*Continued on Data Sheet No. 757*)

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Makes Patterns for

ROLLER CHAIN SPROCKETS

By H. N. Tuttle

PROBABLY 99 per cent of all cast iron sprockets of the detachable link chain type are used directly as they come from the foundry without any machine work on the periphery or tooth profile. In fact many sprockets come from the sand with the bore and key seat accurately in place. Where the chain duty is too heavy or too exacting for the detachable link type, the roller chain is used, and until recently the general practice has been to cut the sprocket teeth with either a rotary cutter or a hob. This was done to obtain the accuracy generally thought necessary for this type of chain. With the modern shape of tooth profile, which permits a little variation in sprocket diameter, and by holding the foundry to close dimensions with the castings, it is found in many cases, that the cast sprocket gives as good results as the one that it cut to accurate dimensions in the machine shop.

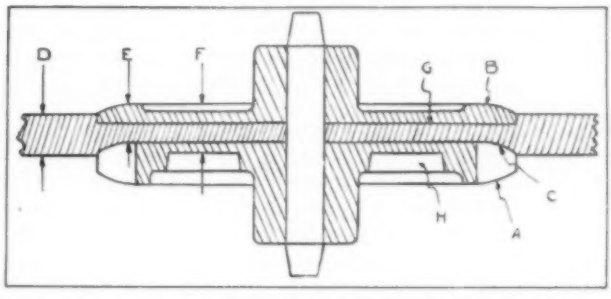


FIG. 1—THE PATTERNS ARE MOUNTED ON A CAST ALUMINUM PLATE

Since these castings must be held to such close dimensions the patterns must be as accurate as is possible to make them. For this reason they should be metal, finished all over, and the teeth cut in a gear cutter. Proper allowances for the rap, swell and roughness, also for shrinkage must be made. Since the patterns are to be cut upon a gear cutter, all dimensions pertaining to the tooth profile must be brought to common rule dimensions, so that the micrometer and other gear cutting tools may be used. For ordinary iron castings this conversion may be made easily by multiplying the dimension by 1.01. This gives a result of 0.005 inch shorter, per foot, than the standard ⅛-inch rule, and accurate enough for most cases. The results are on the safe, or smaller side. For a short cut method the pattermaker usually copies the dimension twice, moving over two places on the second copy, and adds thus:

6.542 — dimension in question
0.06542 — moved over two places

6.60742 — dimension with shrinkage

The pitch diameter is first computed from a table of polygons, or by trigonometry, and the root diameter obtained by subtracting from it the diameter of the chain roller. In ordinary shop practice this dimension is obtained directly from a sprocket wheel table rather than from the mathematical formulas.

Cutters for the tooth profile may be obtained from the supply house cheaper than they can be made. The shape of the modern roller chain tooth is such, that as the chain wears and becomes longer, and the sprocket wears smaller, the roller easily slides up on the flank of the tooth, so that the chain still will run practically as efficiently as when new. From the root diameter must be subtracted a certain amount for rap, swell, and roughness. The writer has found this to be a sliding figure and has in his own practice obtained the best results with the following table which may be extended:

12 tooth sprocket, subtract 0.020 inch
13 tooth sprocket, subtract 0.021-inch
14 tooth sprocket, subtract 0.022-inch
15 tooth sprocket, subtract 0.023-inch

In other words add 0.001-inch swell allowance for each additional tooth. This amount to be subtracted from the theoretical root diameter.

Likewise about 0.030-inch must be taken off the thickness of the tooth at pitch line for back lash. While this amount might be increased slightly for larger sprockets, the writer prefers to omit every other tooth from the larger sprockets, not to reduce the wearing value of the tooth, but chiefly as a convenience in producing the sprocket in the foundry.

The face thickness, or the thickness of the sprocket rim should be kept under the drawing dimension about 0.010-inch for small sprockets and twice this for large ones. Especial care should be taken in the design of the webs, or spokes, as well as with the foundry practice, to prevent warping of the castings. While single metal patterns are satisfactory for small orders, large production requires either stripping plate or match plate patterns. As no special difficulty would be encountered in making stripping plate sprocket patterns, they will not be considered here. With the ordinary method of making sprocket match plate patterns, where the plate and pattern are cast *en bloc*, many small inaccuracies creep in. The

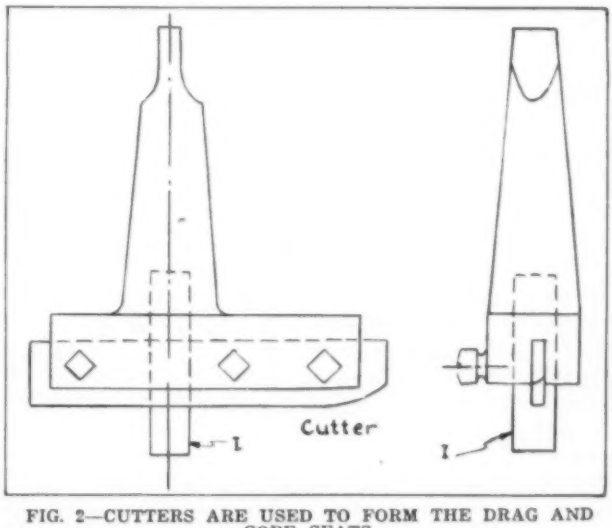


FIG. 2—CUTTERS ARE USED TO FORM THE DRAG AND COPE SEATS

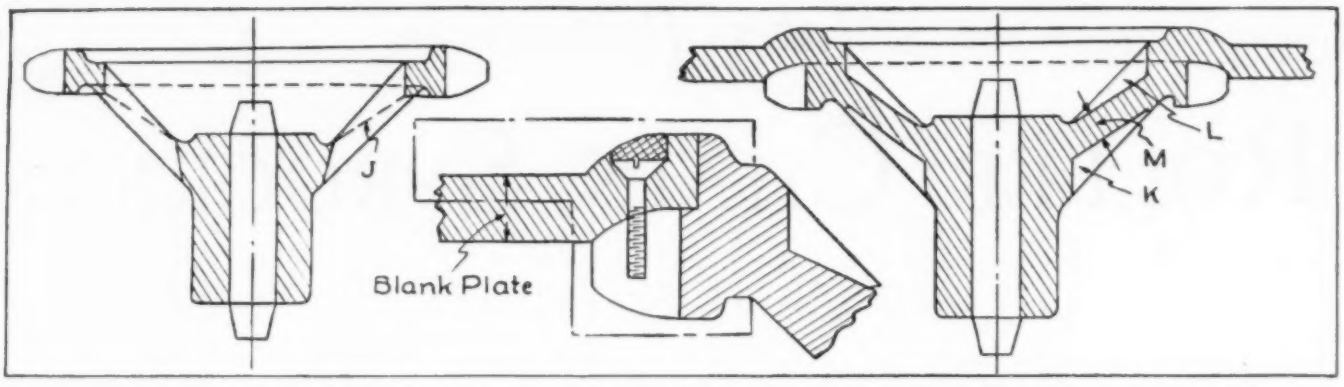


FIG. 3—A DISHED STYLE REQUIRES A SPECIAL PLATE. FIG. 4—A SCREW HOLDS EACH TOOTH IN PLACE. FIG. 5—SECTION OF A DISHED SPROCKET PATTERS THROUGH THE SPACE BETWEEN THE ARMS

aluminum shrinks must be considered. Local shrinkages cause back draft, and must be filed out, causing the pattern to be *out of round*. The rapping of individual patterns, swell and tear up the mold, etc. All these added together make it almost impossible for a standard match plate to be as accurate as a gear cut pattern.

The method of splitting the pattern and mounting it on opposite sides of a plain plate is unsatisfactory for obvious reasons.

Fig. 1 shows a section through one of the patterns of a plate where the cut patterns themselves are mounted on a cast aluminum plate. This plate is extra heavy, usually ½-inch thick, and is made by the same process as any cast match plate, except that no patterns are attached to it.

A shows the cut pattern, which is like the drawing as far as the drag side is concerned, but the cope side is cut to fit a seat of such shape that it easily can be swept out of the plain plate by the tool shown in Fig. 2.

This tool has a pilot *I* the same size as the arbor upon which the sprocket patterns were turned and cut (usually 1 inch). A hole of the same size is drilled and reamed through the blank plate for guiding the sweep tool where each sprocket is to be located. This tool has to be made heavy because of the wide sweeping cut and must be driven by a heavy drill press or miller.

After the seat *C* is swept out, it is covered with spotting paint and both the main sprocket patterns and the cope patterns are fitted accurately by spotting in. The patterns remain upon the arbor while performing this operation. In this way a perfect cope and drag match may be obtained. A slight variation of these surfaces will cause a crush or fin upon the resultant castings. The seat *G* for the cope pattern is swept out in a similar manner by turning over the cutter in tool shown in Fig. 2.

A section through one of the round lightening holes through the web is shown in *H*, Fig. 1. This may be cut with a special end mill. The dimensions through the plate at points *D*, *E* and *F* should be alike, and should be *miked* before the patterns are assembled, and alterations made while it is convenient.

Before the patterns are mounted, they should be scraped carefully to take all the cutter marks from the face of the teeth.

When a dished sprocket, Fig. 3, is required, a special procedure is followed. The dot and dash line *J* shows the mold parting between the spokes. Fig. 5 shows a section of the same sprocket taken through the match plate pattern showing the space between the spokes at *K* and *L* and the plate thickness between at *M*.

It would be difficult to obtain this shape directly in the master pattern to be used for making the blank from which the teeth are cut. It is easy to get it by using the regular match plate process in making the blank castings. A blank master is made with finish allowed upon the hub and rim, but with no finish or extra thickness allowed upon the spokes. In Fig. 7 the hub and rim are shown cross hatched while the finished size is shown in dotted line in the illustration.

After the mold is made from this pattern in the regular way a disk *NN*, amply larger than the sprocket pattern and of standard plate thickness, is placed in position. Sand is rammed around it and out to the usual strips under the flask edges, in the standard match plate way. When the cope is replaced, the extra plate thickness through and around the spokes will be allowed, as shown on the cope side by the dot and dash line.

This casting is bored out for the arbor by trueing up the disk surface *O*, so that subsequently the sprocket will sit squarely on the match plate.

The rim and hub are turned on an arbor while the spoke parts are finished by file and scraper. In getting the length of the hub *P*, plate thickness must be allowed.

The shape to turn the rim is shown in Fig. 4, an enlarged detail through the rim and match plate, showing how the pattern is fastened to the match plate by a screw through each tooth. The dot and dash line shows the surplus metal to be removed in finishing.

Finishing the rim in this shape allows the teeth to be cut by a rotary cutter as well as if the match plate thickness had not been added.

Fig. 6 shows the blank match plate made by merely adding the two disks

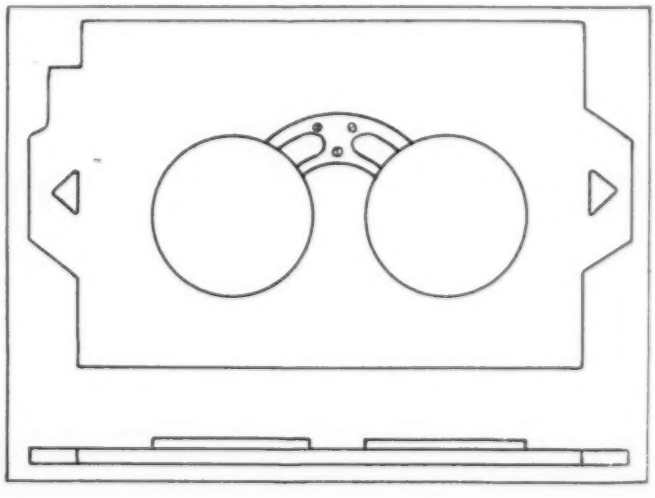


Fig. 6—A blank matchplate with two disks mounted in place

when ramming the blank plates, care being taken by the molder in locating them where desired by the patternmaker.

In case the match plate is to be bored out in the lathe or miller, instead of being swept out, the center part of each disk advantageously could be cored out.

Any set screw or keyway bosses to be added to the hub after turning, may be put on conveniently in white metal cast in plaster molds. The reason plaster is not used more frequently in making molds for addition to metal patterns, is the inconvenience of accurately laying out the lump of plaster after it has hardened.

Cover the pattern with a solution of stearic acid and kerosene (probably the best separating medium to use with plaster). The pattern then may be set up on the surface plate and sufficient center lines scribed with the surface gage upon the pattern. Center lines scribed through the stearic acid will show upon the plaster in fine clear lines. With these as guides the plaster readily may be set up on the surface plate and the desired shape carved out of the plaster with as much accuracy as in wood.

If the plaster be *blobbed* onto the pattern in thick clots, no form usually is needed. The plaster hardens quickly, and is not as likely to cause the white metal to blow. If the mold is tipped up to pour on edge, instead of on the flat and ample vent allowance made, likelihood of blowing is reduced. Slight blows easily are soldered.

The additions usually are anchored to the pattern by drilled holes, or by nails or screws around which the white metal is cast. If the white metal part is to be removed, for convenience in finishing or machine work, no anchors are put in the pattern. The addition is screwed on afterward.

Talks to Foundrymen

Leroy P. Robinson, director of core oil sales, Werner G. Smith Co., Cleveland, spoke at the Feb. 13 meeting of the Philadelphia Foundrymen's association. His subject was "What Will Become of the Foundrymen's Share of the American Dollar." The Philadelphia association is organizing its membership for the purpose of having a large attendance at the American Foundrymen's association convention to be held in Chicago, April 8 to 11.

J. S. McCormick Co., Pittsburgh, has been appointed agent for the Titgen-Eastwood Co., Philadelphia.

British Institute Plans London Meeting

The twenty-first annual general meeting of the British Institute of Metals will be held at the Institution of Mechanical Engineers, London, March 13 and 14, Dr. Walter Rosenhain presiding. The annual dinner will be held on March 13 at the Trocadero restaurant. This meeting will be the occasion to celebrate the twenty-first anniversary of the institute. With that object in view, a conversazione will be held at the new Science museum, South Kensington, in the evening of March 14, in connection with which a metallurgical exhibition now is being arranged.

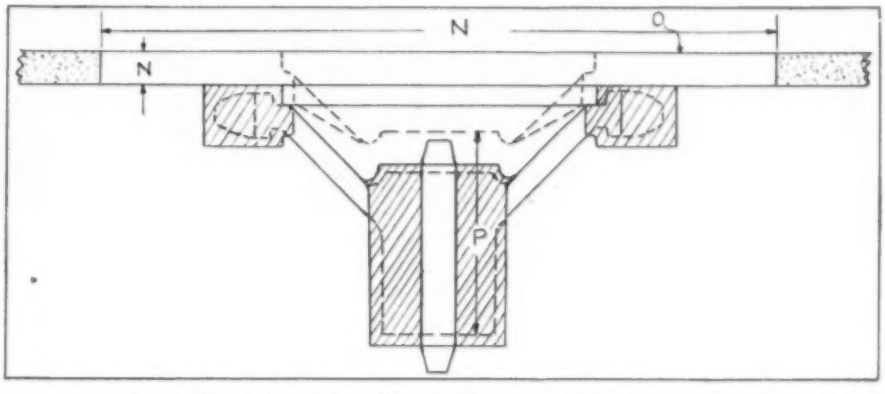


FIG. 7—THE FINISHED SIZE OF THE HUB AND RIM ARE SHOWN BY THE DOTTED LINES

Membership of the institute reached 2000 for the first time on Dec. 31, 1928. A meeting of the council was held on Feb. 21 for the purpose of considering applications for membership.

The following members of the institute who have been nominated for election on the council will be declared to be duly elected at the annual general meeting: president, Dr. Walter Rosenhain; vice presidents, T. Bolton, T. Bolton & Sons, Ltd., London, and Lt.-Colonel Sir Henry Fowler, chief mechanical engineer, London Midland & Scottish Railway Co., Derby; members of council, R. Lloyd Gibbins, Birmingham; H. Moore, London; H. A. Ruck-Keene, London; J. Steven, Glasgow; W. G. Turner, Sheffield; H. B. Weeks, London.

The following papers are expected to be submitted to the meeting: "Recent Developments in Electric Furnaces," by D. F. Campbell; "An Improved Form of Electric Resistance Furnace," by W. Rosenhain and W. E. Prytherch; "Note on the Testing of Electro-deposits on Aluminum," by G. B. Brook and G. H. Stott; "The Importance of Design, and Setting of Large Kettles Used for Refining and Low Melting Point Alloys," by H. C. Lancaster; "Brittleness in Arsenical Copper—II," by Clement Blazey; "Special Properties of Eutectics and Eutectoid Alloys in Binary Metallic Systems," by Professor P. Saldau.

"Work-Softening and a Theory of Intercrystalline Cohesion," by F. Hargreaves and R. J. Hills; "The Age-Hardening of Some Aluminum Alloys," by Marie L. V. Gayler and G. D. Preston; "The Constitution of the Cadmium-Rich Alloys of the System Cadmium-Gold," by P. J. Durrant; "The System Magnesium-Zinc," by W. Hume-Rothery and E. Rounsefell; "Alloys of Zirconium—II," by C. Sykes; "The Resistance of Zinc to Indentation," by J. Newton Friend and W. E. Thorneycroft; "The Solution of Plain and Amalgamated Zinc in Electric Batteries," by J. Newton Friend; "The Silver Contents of Specimens of Ancient and Medieval Lead," by J. Newton Friend and W. E. Thorneycroft; "A Note on the Haughton-Hanson Thermostat," by P. J. Durrant.

To Erect Pipe Foundry

Preliminary work has been started on what is belived to be the first pipe foundry in New England to be devoted to the production of standard sizes of cast iron pipe. It is a $3,000,000 project and is being built at Chelsea, Mass., for the Societe Anonyme des Hauts Furneaux et Fondries de Pont-a-Mousson, France. Herbert Kennedy, Herbert Kennedy & Co., New York, representing the French company in this country, states that the plant will have an initial capacity of 150,000 tons per year. The establishment of a plant in the United States first was conceived by Marcel Paul, chairman of the board of directors of the company, when he visited this country about two months ago. Stone & Webster, Boston, are the engineers who will be in charge of the project.

Monolithic Linings

Numerous Advantages Claimed for Material

BY H. C. ELLIOTT

EXTENT to which monolithic linings in ferrous and nonferrous furnaces have attracted the attention of foundrymen is shown by the many artificial mixtures which have been placed on the market in recent years. First monolithic linings with an over amount of clay and an under amount of silica did not stand up. If a suitable refractory could be found which would vitrify at high temperature it would result in an enormous saving in material and labor. Every foundryman understands that the fusion point is the most important item in a refractory material.

A monolithic lining is designed to take the place of firebrick. Good firebrick are obtainable, but a firebrick lining is dependent entirely on the joints and no matter how carefully the bricks are laid, the joints usually break down before the brick and this results ultimately in breaking down the brick.

When the joint, usually made of fire clay fails, it exposes the edge of the brick to a chemical and mechanical action. The broken edge exposes the soft inner part of the brick which fuses at the corners.

When a firebrick is broken or damaged it is impossible to replace this burned away portion, but the next best thing is done. The break either is daubed up with some kind of material or the holes are chipped out and new brick inserted. This daubing will again fall down and more of the brick is eroded until the whole lining is in such condition that it must be replaced entirely.

The main purpose of a monolithic lining is to avoid weak spots in the form of joints. By eliminating joints, the weakest point in the furnace is taken care of. Naturally the material must possess the ability to be repaired by patching on new material.

A second condition for a satisfactory monolithic lining must be ease of application so that it can be installed readily and repaired by unskilled labor at low cost.

Application of heat to the lining in the beginning must be made carefully and slowly and always must be under control. A certain proportion of water makes the lining material plastic. Therefore a certain amount of moisture still is contained in the rammed monolithic lining. The material should be rammed as hard and as dry as possible. If a strong heat is applied immediately, the moisture will find its way out and damage the lining. For that reason the initial heat must be controlled, a slow fire in the beginning, increased later.

Describes Lining

MATERIALS used in lining the cupola are of interest to foundrymen. If the lining can withstand the temperatures and the heating and cooling without cracking or otherwise disintegrating, considerable time and money will be saved. This article, which is abstracted from a paper presented at a recent meeting of the Buffalo Foundrymen, Buffalo, describes the various features claimed for one type of lining. The author is connected with the Alpha-Lux Co. Inc., New York.

Quick changes of temperature in cupolas, converters and other melting and metallurgical devices, introduce the item of expansion and contraction.

Every fireproof mass rich in silica which contains free quartz will undergo a change of elongation of about 0.5 per cent and a change of the mineralogical form of the quartz each time it is heated and cooled between the extremes of atmospheric temperature and 1067 degrees Fahr.

However, if such masses are heated for a considerable period to above 2404 degrees Fahr., part of the quartz will be changed to christobalite. From examination or measurement of the heat expansion coefficient it is apparent that up to 1112 degrees Fahr. the mass when burned to seeger cone 09 as well as seeger cone 15 is sensitive to changes of temperature. This explains why the first application of heat must be gradual, uniform and slow. After attaining a temperature of 1112 degrees Fahr., no more sudden cracking of the lining is to be expected.

Conditions in a foundry are not always ideal, due to certain local conditions which must be considered, but usually a monolithic lining will show many advantages over brick due to the many features outlined. Introduction of a superior material and the attention it attracts usually results in improved cupola practice.

A single row of tuyeres is recommended with a ratio of 17 to 20 per cent to the cross sectional area of the cupola. Cupola lining should be kept to original size and shape. Slag to be taken off at regular intervals. When melting high silicon iron, use a reasonable amount of limestone to keep the cupola clean. Cut the limestone down to a minimum when melting white iron, large percentages of steel or high manganese iron. Manganese oxide forms a silicate and fuses with the lining. Iron oxide has a similar effect. Excess limestone forms a basic slag which reacts at once on the lining. When melting semisteel, the oxide, manganese and iron will take care of most of the fluxing. Ordinary fireclays begin to soften under load at a point far below their actual melting point.

Foundry Safety Improves

Statistics compiled by the department of labor and industry of the state of Pennsylvania show a decrease in the number of accidents in the foundry industry in that state. The data for the month of October 1928 shows that the index number decreased 3.7 per cent for the month as compared with the previous month. The index number is taken as the difference between the index numbers of the years 1923 and 1925 and is expressed as 100. The record also shows that there was an increase of 10.4 per cent in the total weekly employe hours over the preceding month and that the average hourly earnings had increased 0.7 cents during the same period of time.

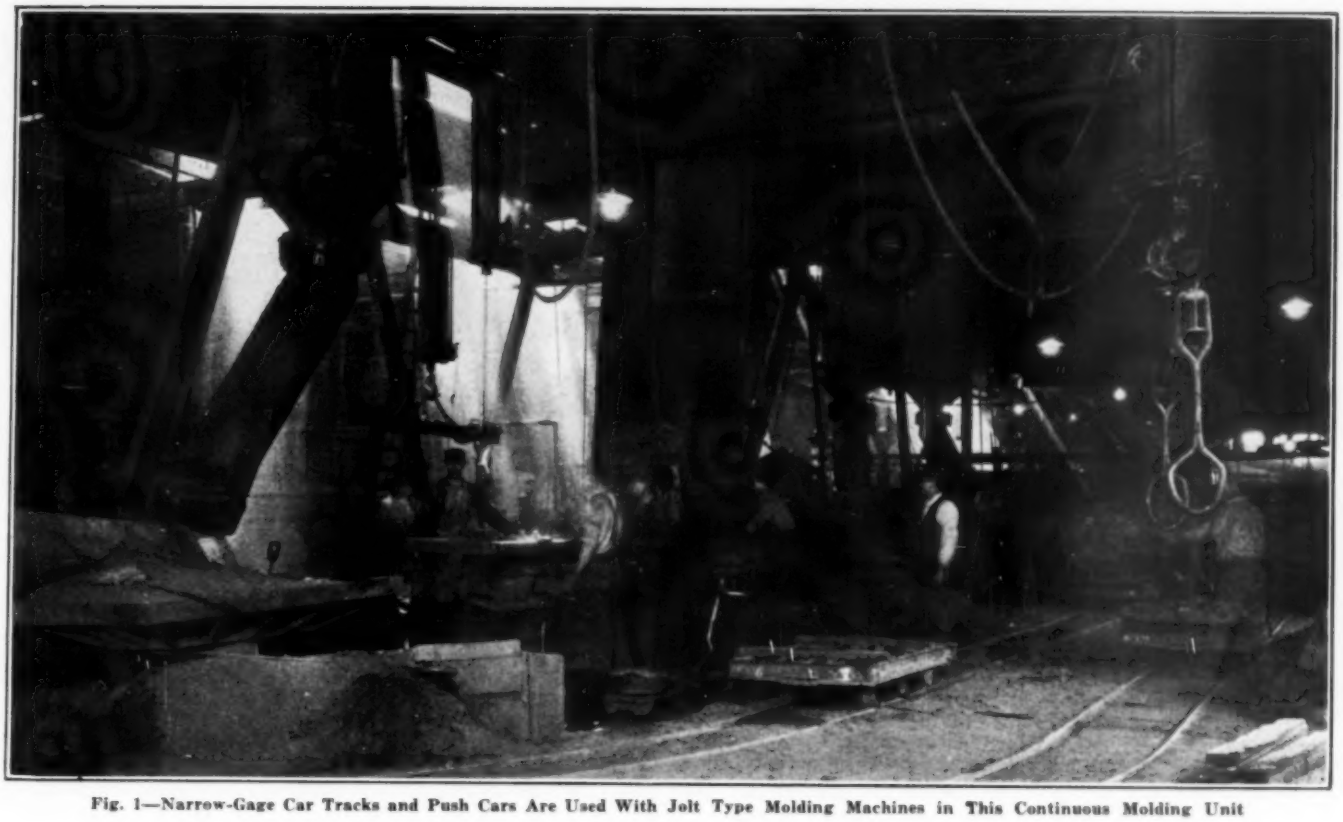


Fig. 1—Narrow-Gage Car Tracks and Push Cars Are Used With Jolt Type Molding Machines in This Continuous Molding Unit

MOLDS ENAMEL WARE on Continuous Units

By J. B. Nealey

AS THE use of enameled ware has increased, the processes incident to its manufacture have been improved and modernized to provide greater production. The enamel ware plant of the Richmond Radiator Co., Uniontown, Pa., is a typical establishment making that type of product. Buildings housing the various departments are constructed of brick and steel and the equipment is of modern design. The molding, cleaning and finishing, enameling, assembling and crating departments are situated in these buildings. Straight line production is used, the product passing through the plant in a straight line until it is finished and ready for shipment.

The storage space for pig iron, coke, and limestone is located on a line with the cupola charging platform. The railroad siding also is at this same level. That arrangement eliminates elevating the charging material to the cupola platform. In the foundry, large ware, such as bath tubs and sinks, is made on jolt type molding machines, which are a part of the continuous molding system.

The molding units have a narrow-gage car track laid in the shape of an oval about 50 feet long. Three stations are located at intervals along the track. The molds are made at the first point in the system. Jolt type machines and a part of one of the continuous molding units is shown in Fig. 1. After the molds are made they are placed on small flat cars and pushed along to the second station where they are poured. Shortly after the pouring operation, the molds are shaken out. The cope and drag flasks are replaced on the cars and returned to the molding unit for further use. The sand from the molds falls into a reciprocating type conveyor, is tempered elevated and delivered to the different overhead bins to be used over again.

After the castings have been shaken out they are placed on cars which run on a track that connects the shakeout with the cooling floor. After reaching that point, they are allowed to cool. The castings then pass through a series of sandblast rooms where they are cleaned. It is imperitive that all sand be removed from the castings to prevent trouble during enameling operations.

The clean castings are delivered to the grinding room where they are ground, filed and smoothed with a rub stone. After a rigid inspection the castings are sent to the enameling department where they are given a coat of slush as illustrated in Fig. 3. This liquid is poured over the casting. After the coating has dried thoroughly the castings are ready for the enameling operation.

The furnaces used to fuse the enamel upon the castings are of brick construction. They are heated with gas to a temperature of between 1700 and 1750 degrees Fahr. The furnaces are equipped with doors that are raised

FIG. 2—AT THE LEFT, IS A CAR IN POSITION READY TO DROP A BATCH INTO A HOLE IN THE TOP OF THE FURNACE. ONE OF THE FURNACES USED TO DRY FRIT IS SHOWN AT THE RIGHT

and lowered by compressed air.

The castings are placed in the furnaces and when they have been heated to the required temperature, they are removed from the furnace with a long fork that is well balanced and easily handled by the enameler and his helper. The ware then is placed on an enameling table which is constructed in such a way as to permit the ware to be turned at any angle. This facilitates the application of the enamel powder.

The powder is applied with an air vibrator which is attached to a sieve about 10 inches in diameter as shown in Fig. 4. After the application of the powder the casting is returned to the furnace with the fork. It is the usual practice to apply 2 or 3 coats of enamel powder during the enameling operation. This is known as the dry enameling process.

The making of the enamel or frit is an interesting operation. Enamel is mixed according to a formula that is similar to that used in the production of glass. Practically the same ingredients are required for making enamel as in the manufacture of glass. The ingredients commonly used for making enamel are as follows: Feldspar, soda ash, antimony, tin, zinc oxide, borax, litharge, fluorspar, nitrate of soda and flint. After the different materials are mixed sufficiently, the conglomerate commonly is known as a batch and is ready to be melted.

The melting furnaces are of brick construction. They are fired with gas, and are heated to a temperature of 2250 degrees Fahr. The enamel batch is placed in a car, that is operated on an elevated track directly over the top of the melting furnaces. The batch is discharged from the car into an opening in the top of the furnaces as shown in Fig. 2. After the batch is melted, which requires about 3 hours, it is ready to be withdrawn from the furnace. The batch is in a molten or liquid state and is withdrawn from the furnace through a tap hole and allowed to run into a pit filled with clean water. It is stirred while running into the water to break it into finer particles. At this stage the enamel is commonly spoken of as frit.

The frit is removed to a rotary drier, which is heated by gas and makes 12 revolutions per minute, thus permitting the frit to be dried thoroughly without burning. This is shown in Fig. 2. The dried frit then is placed in pebble mills approximately 5 feet in diameter and revolving about 26 revolutions per minute. The mills are of steel and cast iron construction and lined with white porcelain brick. The frit is loaded into these mills with white porcelain pebbles about 2½ inches in diameter. The

(*Concluded on Page* 218)

FIG. 3—BEFORE THE ENAMELING OPERATION THE CASTINGS ARE GIVEN A COAT OF SLUSH. FIG. 4—THE POWDERED ENAMEL IS APPLIED WITH A VIBRATOR OPERATED BY COMPRESSED AIR

WHAT OTHERS ARE THINKING

Abstracts Selected from the World's Foundry Literature

Gives Drying Data

Electrically Heated Drying Stoves in the Foundry, by E. Diepschlag. *La Revue de Fonderie Moderne*, Paris, Jan. 10, 1929.

This article consists mainly of a technical discussion on the process of drying, and on the use of electrically-heated ovens. It describes a series of tests conducted on a wooden tube of 0.63-square inch section, at the lower end of which are stretched eight resistance chrome-nickel wires. Each wire is stretched on a wooden frame. The eight frames form four groups of two which are connected in parallel, thus forming four sets of equal resistance. An air inlet is provided at the bottom of the tube, which is 9.84 feet high; the incoming air can be measured. The upper end of the tube is open. At the outlet the air duct is connected with a fan.

The quantity of air entering is measured and maintained constant. The current is put on to one set of resistance and the conditions are maintained until equilibrium is reached between the incoming and the outgoing heat. The temperatures and intensity of current then are plotted, and the operations are started again with the second, third and fourth sets of resistances.

Curves and a table show that: (1) For a given volume of air the absorption of heat decreases with the increase of the final temperature; (2) This decrease diminishes as the temperature increases; (3) For a given volume of air the increase of temperature decreases as the heat introduced increases; (4) The increase of temperature decreases further as the volume of air introduced increases. The article concludes with considerations on the cost of operation.

Describes Sand Testing Methods

Formsanduntersuchung, by H. Nipper and E. Piwowarsky, *Die Giesserei*, Duesseldorf, Nov. 2, 1928.

The authors carried out a great many sand tests for the purpose of creating a basis for the judgment of natural molding sand. The work divided itself into two main sections, namely, summaries of the results of foreign workers and that done in Germany. The work done by the authors is described at length. Two types of sand were used. One is river sand and the other is ground quartz. These sands were used to determine the difference between round-grain sand exemplified by the river sand, and the sharp-grain sand exemplified by ground quartz. The two sands were made into synthetic sands by the addition of clay ranging from 4 to 30 per cent, and the water from 0 to 20 per cent. The clay was added dry and mixed for two minutes. Water then was added and the whole mixed for 5 to 10 minutes to make a homogeneous mixture.

Test pieces were made on a machine designed by Nipper which gave a definite jarring action. After a number of tests with carbon dioxide as the gas, the permeability standard flow was set at 175 liters per hour. Temperature tests showed that little variation was encountered with a range from 18 to 62 degrees. Tests then were conducted on the variation of mixing time, with little difference noted. In the formation of the test pieces the method was standardized at 50 jolts with a drop of 32 millimeters. The sand test pieces are 56 millimeters in diameter, 60 millimeters high with a base surface of 25 square centimeters. Pressures of gas on the test pieces are measured by a differential manometer and a direct pressure manometer.

A number of tables are presented to show the results of the various tests. With permeability it is found that each grain size has the greatest permeability with a definite clay content and water content. With the same grain size, the maximum permeability is attained with high clay and water contents. With increasing grain fineness in sharp sand, the maximum permeability decreases with decreasing clay content quicker than with round grains.

Experiments also were made to determine the influence of blacking the mold surface. Where the surface is moist a strong decrease of permeability was noted. However, drying of the mold lessened this effect. Influence of additions of coarse sand is greater than additions of fine sand.

Uses Nickel and Chromium Additions

Ueber nickel-und chromliegertes Gusseisen, by E. Piwowarsky, *Die Giesserei*, Duesseldorf, Oct. 26, 1928.

The effect of nickel and chromium additions upon cast iron is discussed by the author with reference to the various researches and investigations relating to the subject. Nickel carbide is unstable. Its heat of formation is strongly endothermic and nickel additions to iron and steel at first form mixed crystals with the free iron. In these mixed crystals nickel decreases the speed of gamma to alpha transformation. Ferrite crystallization proceeds in ranges of increased undercooling until with high nickel content, austenite becomes the stabile crystal. Nickel increases the hardness of the matrix by changing the convertible structure to martensite.

Chromium, on the contrary, is a decided carbide former, and therefore works increasingly upon the hardness and combined carbon. Nickel affects the toughness and uniformity of cast iron while chromium, on the other hand, affects the strength and grain size. Perhaps from the standpoint of dynamic stresses a combination of nickel and chromium is especially favorable particularly from observations of chrome-nickel steel where the combination of both elements provides the attainment of the highest value against impact stresses. Investigations with nickel show a 10 to 20 per cent increase of strength properties. Bauer, Piwowarsky and Ebbefeld found that 1 per cent nickel addition is a maximum, for further addition gave a marked coarseness of the graphite. Later Piwowarsky and Freytag found that if nickel replaced some of the silicon, additions of nickel up to 5 per cent gave only a slight coarsening of graphite especially if the iron has been melted hot or has been superheated strongly. Although Hase reported a reduction of 50 per cent in acid corrosion with nickel additions, Piwowarsky and Koetschke found only about 20 per cent increase in corrosion value. Nickel additions up to 5 per cent improve the alkali resisting properties of cast iron. The author also refers to the use of nickel and chromium for steel mill rolls and of the use of nickel for castings used in the electrical industry, such as resistance grids and nonmagnetic cast iron.

Use Permanent Molds

Permanent Molds for Iron Castings, *Foundry Trade Journal*, London, Dec. 13, 1928.

In Germany the Buesselmann firm at Hannover has developed a permanent mold process using a mixture of fireclay, kaolin, coke, quartz sand and molding sand to form the mold. Generally the composition consists of two parts of ground fireclay, two parts of kaolin, one part coke, three parts quartz sand, three parts clay water and four parts Ellriche sand (high quality green sand). Variations of this may occur in different localities; using as much as four parts of clay instead of the two mentioned. Materials are ground, mixed and moistened, and then worked thoroughly in an edge-runner or other mill to obtain a homogeneous mixture. Backing sand must be fatter than that usually employed to prevent loosening in the flask. With reasonable attention to preparation of the mixture, backing sand and the making and treatment of the mold, 20 to 30 castings may be expected where the flask size is not over 1 square yard. Addition of two to four parts of asbestos to the mixture is said to increase its permanence 20 to 25 per cent. No special molding boxes, patterns or pattern plates are required. In certain castings it may be necessary to use a larger number of cores if there is danger to the mold or casting due to contraction. For the same consideration, openings for gates and risers are formed in a more yielding mixture. Thorough drying of the mold is essential for the manufacture of good, clean castings.

The Shakeout

DAN M. AVEY, Editor
PAT DWYER, Engineering Editor
EDWIN BREMER, Metallurgical Editor
FRANK G. STEINEBACH, Managing Editor
CHARLES VICKERS, Nonferrous Editor
NORMAN F. HINDLE, Assistant Editor

¶ The World Do Move

LIKE many another topical allusion or catch phrase, bandied about usually in a facetious manner by people who, in some instances, have not the slightest conception of its origin or the circumstances responsible for its existence, the famous old phrase *The World Do Move* is based on a fundamental truth. Fundamental truths are stubborn things. They are impervious to specious reasoning. They cannot be ignored, pushed impatiently out of sight, or forgotten. There they are and there they will remain. The sensible man is the man who recognizes them for what they are and shapes his future course of action accordingly. History, whether local, national or universal over any or all periods of time, is silent witness to the truth of the statement *The World Do Move.* Also it is witness to the fact that to succeed in practically any line, one must move with the world.

FOR a great many years, metals in the cast form filled every requirement, or almost every requirement in commerce and industry. Gradually—and this particularly is true in the years that have elapsed since the beginning of the present century—other materials and metals in other forms have been developed extensively to meet greater and greater demands on the part of mankind to extend his supremacy on land on sea and in the air.

STEEL and concrete are the greatest competitors of castings in the industrial field. Increased consumption of these materials year by year is due in part to natural conditions and to their particular fitness for use where they have been employed. It is due in much greater measure to the fact that manufacturers of these materials are keenly alive to the fact that *The World Do Move.* They have not waited for customers to develop a need. They have anticipated the needs in many lines and then persuaded customers that their goods were particularly suitable to meet these needs. They have shouted the merits of their wares from the housetops and the world has taken note. Castings fill a basic need and the great bulk always will be ordered without solicitation, but the foundryman who wants to stay in the industrial procession and secure his legitimate share of all available business, will do well to note the tactics practiced by outside competitors in other materials. Also he will do well at all times to bear in mind that *The World Do Move.*

¶ Gives Poor Impression

SINCE the success of practically all industries depends upon proper transportation facilities, many manufacturing establishments are located near railroads. In fact, the right-of-way of nearly any railroad entering an industrial center, is lined with factories of various types. Foundries are included in the class of industry seeking sites near railroads, since they are dependent on that type of transportation for raw materials, such as pig iron, nonferrous metals, scrap, fuel, limestone and sand, while often the finished castings are sent to the buyer by rail.

AMERICAN business men, traveling from one point to another, must pass through these industrial sections. Many buyers of castings may be included in the army of travelers which speeds through the canyons walled in by factories, mills, packing plants, elevators and numerous other industries. To a certain extent, the physical condition of any plant along the railroad may influence the opinion which may be formed in the mind of the traveler regarding the industry of which the plant is a member.

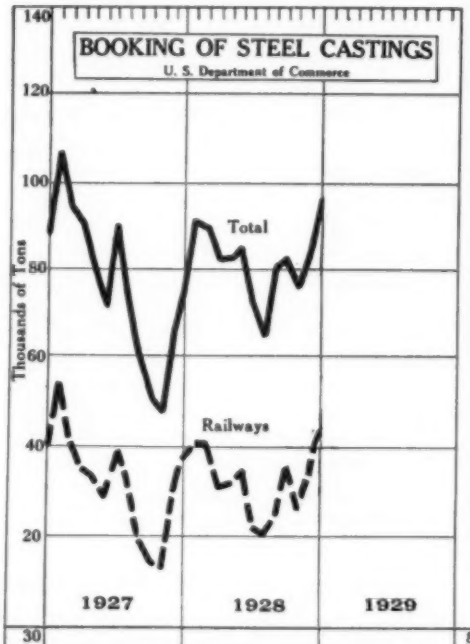
FOR this reason foundrymen should pay more attention to the appearance of yards and buildings. In too many instances, the foundry yard along the railroad is cluttered with flasks, pig iron, scrap, coke and other materials scattered haphazardly about the place, presenting anything but an orderly appearance. The traveler, who may be a buyer of castings, a plant owner or an engineer directly or indirectly interested, may judge the entire foundry industry by some of the poorly kept plants seen along the railroad right-of-way. Would it not be better for the industry as a whole if every foundryman placed his foundry yard in order?

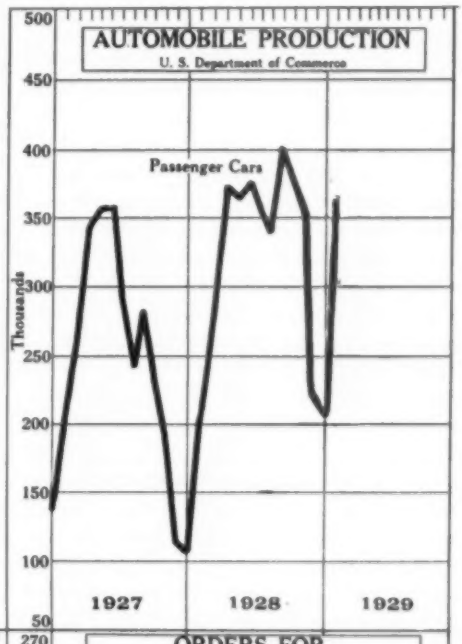
Trade Trends in Tabloid

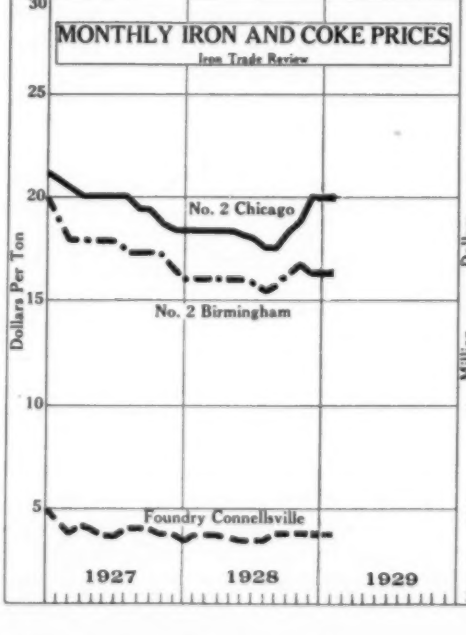
FOUNDRY business is good. This is the picture of the present business situation presented wherever foundrymen gather to exchange views. In the east, jobbing shops are increasing their operations with the advance of Spring. Pittsburgh foundry activity is increasing, supported by larger casting demands from the iron and steel industry. Automotive foundries are working at top speed. Stove and radiator plants are maintaining a high rate of operation. Substantial car buying reported in early February, which is expected to bring the month's total to 11,000 to 12,000 units, promises better business for steel foundries. Brass foundries making automotive work are busy. The same condition applies among those foundries supplying restaurant and soft drink manufacturing and purveying equipment. Plumbing goods shops report operations satisfactory, but not on as high a scale as many other lines. Cast-iron pipe foundries have orders ahead that indicate steady operation through the first half of the year. Building operations as reflected by awards indicate that the present year probably will sustain the demand for castings from this source. January automobile production established a record for that month with a total of 350,617 passenger cars in the United States and 17,164 cars in Canada. A substantial buying movement of pig iron for second quarter is noted.

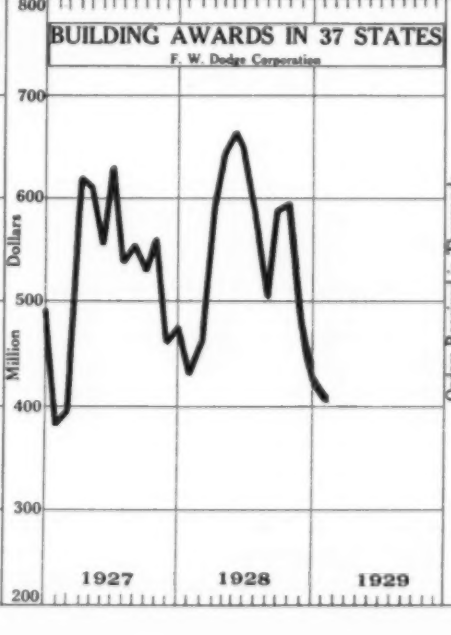
RAW MATERIAL PRICES
Feb. 22, 1929

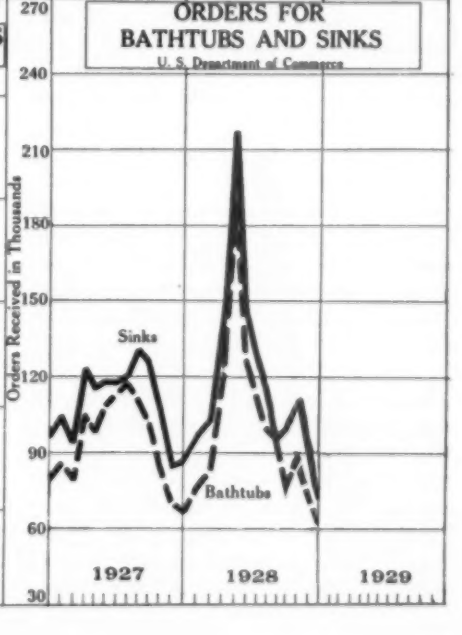
Iron	
No. 2 foundry, Valley	$17.50
No. 2 southern, Birmingham	16.50 to 17.00
No. 2 foundry, Chicago	20.00
No. 2 foundry, Philadelphia	21.26 to 21.76
No. 2 foundry, Buffalo	18.50
Basic, valley	17.50
Basic, Buffalo	17.50
Malleable, Chicago	20.00
Malleable, Buffalo	19.00
Coke	
Connellsville foundry coke	$3.75 to 4.85
Wise county foundry coke	4.25 to 5.25
Scrap	
Heavy melting steel, Valley	$17.50 to 18.00
Heavy melting steel, Pitts.	18.00 to 18.50
Heavy melting steel, Chicago	15.75 to 16.25
Stove plate, Buffalo	14.50 to 14.75
Stove plate, Chicago	12.75 to 13.25
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	16.00 to 16.50
No. 1 cast, Philadelphia	16.00 to 17.50
No. 1 cast, Pittsburgh	14.00 to 14.50
No. 1 cast, Birmingham	16.00
Car wheels, iron, Pittsburgh	15.50 to 16.00
Car wheels, iron, Chicago	14.50 to 15.00
Railroad malleable, Chicago	19.00 to 19.50
Agricultural mal., Chicago	15.50 to 16.00
Malleable, Buffalo	17.50 to 18.50
Nonferrous Metals	Cents per pound
Casting, copper, refinery	17.75
Electro, copper, producers	18.00
Straits tin	49.00
Lead, New York	6.95
Antimony, New York	9.50
Nickel, electro	35.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	16.50 to 17.00
Zinc, East St. Louis, Ill.	6.35











Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

M. J. GREGORY, formerly foundry superintendent for the Lakey Foundry & Machine Co., Muskegon, Mich., Ferro Machine & Foundry Co., Cleveland, and for the General Motors Corp., Detroit, has accepted a similar position with the Caterpillar Tractor Co., Peoria, Ill.

H. M. Molder, formerly manager of the Best Foundry Co., Bedford, O., has joined the Dangler Stove Co., Cleveland.

Edwin H. Peirce has resigned as vice president and general manager of the Niles Tool Works Co., Hamilton, O.

J. E. Mullen, formerly sales manager of the Westinghouse-Nuttall Co., Pittsburgh, has accepted a position with the National Foundry Co., Erie, Pa.

William W. Brierly, president, Millbury Steel Foundry, Millbury, Mass., was re-elected president of the Employers Association of Central Massachusetts at its recent annual meeting.

Frank Purnell, assistant to the president of the Youngstown Sheet & Tube Co., Youngstown, O., has been elected a director of the Youngstown Foundry & Machine Co., Youngstown, O.

T. K. Moulsdale and F. Grinshaw Martin, B.Sc., F. I. C., have been appointed secretary and technical director respectively of the British Perlit Iron Co., 9 Rumford street, Liverpool, Eng.

Scott Scammell, Trenton, N. J., and Edward W. G. Borer, Philadelphia, have been added to the board of directors of the Erie Malleable Iron Co., Erie, Pa. They will represent the John A. Roebling's Sons Co., Trenton.

James Thompson, chief engineer, Hubbard Steel Foundry Co., East Chicago, Ind., and chairman of the mayor's sanitation committee, of East Chicago, has also been appointed chief engineer for the newly created East Chicago sanitary district.

Robert W. Gillispie, vice president and general manager of the Jeffrey Mfg. Co., Columbus, O., since October, 1927, has been named president and general manager of the Galion Iron Works & Mfg. Co., Galion, O., which recently was acquired by the Jeffrey company. Other officers of the Galion company are: D. C. Boyd, chairman of the board; J. S. Body, vice president; and F. W. Faber, secretary-treasurer. Mr. Gilliespie was for many years identified with the Bethlehem Steel Co., Bethlehem, Pa., and before locating in Columbus in July, 1926, was assistant manager of structural and plate sales.

Clifford Hubbell, has been added to the directorate of the Lumen Bearing Co., Buffalo brass and bronze casting manufacturer, suceeding the late Samuel Ellis.

HUTTON H. HALEY

Frank T. Bumbaugh has been elected president of the Monessen Foundry & Machine Co., Monessen, Pa., to suceed the late W. S. Bumbaugh.

Instructors To Meet at Foundry Convention

Instructors of engineering schools interested in the development of materials for engineering construction have been extended an invitation to be present at a dinner and special meeting which will be held at the Stevens hotel, Chicago, April 8, under the auspices of the American Foundrymen's association.

This meeting is an outgrowth of the foundry instructors meetings which have been held in connection with the annual conventions of the association. Following the dinner, the group will be addressed by a prominent foundryman on, recent developments in casting metals. Prof. J. D. Hoffman, director of the department of practical mechanics of Purdue university, will preside at the dinner. Profs. A. E. Wells of Cornell university and J. Grennan of the University of Michigan are serving with Prof. Hoffman on the committee.

Returns to Detroit

Hutton H. Haley, vice president, the American Foundry Equipment Co., Inc., Mishawaka, Ind., has returned to Detroit as representative of the company. Mr. Haley was the company's representative in Detroit from 1914 to 1925. He joined the forces of the American Foundry Equipment Co. in 1911 and for three years was in charge of the eastern sales. In 1914 he was appointed vice president and took charge of the Detroit office. In 1925 the executive offices and the factory organization were combined at Mishawaka and Mr. Haley went there as vice president in charge of sales. The move was not of a permanent character and on Jan. 1, he returned to Detroit to resume his old duties.

Note Cast Iron Progress

The first regular meeting of the New England Foundrymen's association for the current year was held at the Exchange club, Milk and Batterymarch streets, Boston, Feb. 13. The meeting was addressed by Dr. Richard Moldenke who spoke on the subject "Recent European Developments in Cast Iron."

Die Casting Data

The Universal System of Machine Moulding and Machinery Co., Ltd., 13/15 Wilson street, London, has issued a bulletin covering aluminum pressure die casting equipment. The bulletin contains photographs of the machine and a typical installation. Some sample castings are also shown. It contains a list of the advantages of this method of molding with a chart showing the limit of accuracy.

Considers Castings Used in Power Equipment

Power plant design and metallurgical problems in power plant and power transmission equipment were among subjects considered at the fourth Midwestern Engineering and Power conference held at the Palmer house, Chicago, Feb.12-15. At the same time the Midwestern Engineering and Power exposition was held at the Coliseum. Metallurgy of materials used in power equipment was discussed by Prof. A. E. White, head of the department of metallurgy and director of the research laboratories of the University of Michigan. He outlined practical means of detecting material unacceptable for power plant equipment and transmission line work. He stated that the use of metals in modern power plant equipment is undergoing marked transition, ordinary and special alloys and alloy steel replacing other types of materials. Control of weight in castings, core processes and regulation of the relative weights of risers were described as significant problems in producing acceptable castings for power plant equipment.

Stability at elevated temperatures is highly desirable in such alloys as 9 per cent chrome and 8 per cent nickel, and low chrome and low tungsten alloys, and Dr. White used illustrations of metallurgical tests of these alloys in comparison with plain carbon steel and other steel.

Practical methods of examining metals for power plant equipment were illustrated, such as the photomicrograph and sulphur prints. These detect inclusions, cracks, decarburization and direction of fibers. The practicability of the X-ray in examining castings for internal gas cavities, blowholes, sand and slag spots, porosity, metal segregation and location of strains was shown. Transverse sections only were chosen in the examination of such equipment as turbine disks and shafts. The exposition constituted more than 300 booths showing a diversity of equipment exhibits. A special effort was made to group exhibits of the same class at this year's show, many of the exhibits showing machinery in operation. A variety of fuel-burning exhibits and a large number of pumps and units of pumping equipment were on display. Progress made in boiler manufacturing was demonstrated in a number of exhibits. A special section was assigned to power transmission equipment. The section devoted to heating and ventilating equipment was larger than it has been heretofore.

Faked Foundry Facts

A "Light" Jacket

Northern Blower Co., West Sixty-fifth street and Barberton avenue, Cleveland, is building a 75 x 125 foot addition to its plant.

Foundry Association Directory

American Foundrymen's Association

President, S. T. JOHNSTON, S. Obermayer Co., Chicago; secretary-treasurer, C. E. HOYT, 222 West Adams street, Chicago; technical secretary, R. E. KENNEDY, 222 West Adams street, Chicago.

Associated Brass Founders of New England

President, J. A. DUNCAN, Wm. Duncan & Sons Co., 166 Liverpool street, East Boston, Mass. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. MCARTHUR, Washington Iron Works; secretary, W. J. WARK, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. HIRE, Hire Foundry Co., Peoria, Ill.; secretary, FRANKLIN WHITEHEAD, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, DAVID G. ANDERSON, Western Electric Co.; secretary, ALBERT N. WALLIN, S. Obermayer Co., 2563 W. Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, FRED W. STICKLE, 25 Woodrow street, West Hartford, Conn.; secretary, C. S. NEUMANN, Union Mfg. Co., New Britain, Conn. Meetings are on second Friday of each month in various parts of the state.

Detroit Foundrymen's Association

President, J. J. BOLAND, Griffin Wheel Co., Detroit; secretary, ROBERT HOPE, 5502 Ivanhoe, Detroit. Meetings third Thursday in each month at appointed place.

East Bay Foundrymen's Association

Secretary O. R. MOLLER, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Gray Iron Institute

President, WALTER L. SEELBACH, Forest City-Walworth Run Foundries Co., Cleveland; Secretary, ARTHUR J. TUSCANY, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, F. L. SIVYER, Rockford-Northwestern Malleable Corp., Rockford, Ill.; secretary, ROBERT E. BELT, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President WILLIAM EMBER, Jefferson Brass Foundry, 62 Delevan street, Brooklyn N. Y.; secretary, WILLIAM E. PAULSON, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue, New York.

Newark Foundrymen's Association

President, J. L. CARTER, Sachs-Barlow Foundries, Inc., Newark; secretary W. H. MANTZ, Atlas Foundry Co., Irvington, N. J. Meeting called by president.

New England Foundrymen's Association

President CARL S. NEUMANN, Union Mfg. Co., New Britain, Conn; secretary, FRED F. STOCKWELL, 205 Broadway, Cambridgeport, Mass. Meetings second Wednesday of each month at the Exchange club, Boston. Outings usually are held in the summer months.

Ohio Foundries Association Inc.

President, C. C. SMITH, Toledo Steel Casting Co., Bancroft and Smead avenue, Toledo, O.; secretary-manager, E. F. SCOTT, 418 Penton building, Cleveland.

Philadelphia Foundrymen's Association

President, WALTER WOOD, R. D. Wood & Co., Philadelphia; secretary HOWARD EVANS, Union League club, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Southern Metal Trades Association

President, GEORGE B. COCKER, Gastonia, N. C.; secretary, W. E. DUNN JR., Healy building, Atlanta, Ga.

Pittsburgh Foundrymen's Association

President, W. P. BRADLEY, Wheeling Mold & Foundry Co.; secretary-treasurer WILLIAM J. BRANT, Wm. J. Brant, Bessemer building, Pittsburgh. Meeting on the third Monday of the month, except in July and August, at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, A. D. MATHESON, French & Hecht, Davenport, Iowa; secretary-treasurer, HUGO WOLF, Frank Foundries Corp., Davenport, Iowa. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

Tri-City Technical Council

Chairman F. V. SKELLEY, Tri-City Railway Co., Rock Island, Ill.; treasurer, MAX SKLOVSKY. Deere & Co., Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, A. G. WESSLING, Wessling Bros. Foundry Co., 1607 McLean avenue; secretary, GEORGE W. PIEHL, Wessling Bros. Foundry Co., 1607 McLean avenue. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, WILLIAM E. LOBERG, American Hoist & Derrick Co., St. Paul; secretary-treasurer, C. E. LANGDON, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club

President, J. W. ORPHAN, Lake Union Foundry Co., 1703 Westlake avenue, Seattle; secretary, EDWARD C. GUSTIN, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Obituary

H. L. Conlon, manager, Gartland Foundry Co., Terre Haute, Ind., died Sunday Feb. 17, at his home in Terre Haute.

R. J. Kvalheim, general superintendent, Crown Iron Works, Minneapolis, died Jan. 15 at the age of 40 years.

Michael D. Waldron, general supintendent, Richardson & Boynton Co., Whitesboro, N. Y., died at his home in Utica, N. Y., Feb. 4. He was born in Utica in 1868 and became well known for his inventions used in the heating trade. Prior to his employment with Richardson & Boynton Co., he was general superintendent of the Utica Heating Co., Utica, N. Y.

William S. Bumbaugh, aged 62, president of the Monessen Foundry & Machine Co., Monessen, Pa., which he founded in 1898, died Feb. 8 in his home in Belle Vernon, Pa., after an extended illness.

Former General Electric Official Dies

Matthew Griswold, formerly manager of the Erie, Pa., works, General Electric Co., died at his home in Erie, Feb. 10. Mr. Griswold was born in Erie in 1866, and was graduated from Sheffield Scientific school, Yale, in 1888. After two years of post graduate work he obtained the degree of M. E. Upon leaving college he became associated with the Griswold Mfg. Co., of which he served as president for a number of years. On Nov. 11, 1911, he severed his connection with the Griswold company to become acting manager of the Erie works of the General Electric Co. He was made manager of the plant on Dec. 12, 1912. Mr. Griswold had retired as manager of the Erie plant on January 1, because of ill health.

High Frequency Furnace Used To Melt Steel

(*Concluded from Page* 194)

24 hours. The power consumption is calculated to be approximately 300 to 350 kilowatt hours a ton.

During the decarburization period a hot flame is formed and with this flame the air could be heated in a recuperator or regenerator.

Fig. 11 shows the power consumption for melting iron scrap in different coreless induction furnaces compared with arc furnaces, according to Sommer, *Stahl* und *Eisen*, 1926. The data are from the following furnaces:

The comparison of small high frequency furnaces (with extremely great radiation losses) with 1-ton arc furnaces shows that there is no doubt that large high frequency furnaces will consume no more power than arc furnaces perhaps less.

It can be said that the introduction of large coreless induction furnaces in steel metallurgy promises to better not only the quality but also the economy of present day electric steels.

Appoints Committees

At the January meeting of the board of directors of the Gray Iron institute the appointment of the following committees were approved:

COST COMMITTEE

Chairman—J. L. Carter, Sacks-Barlow Foundry Co., Newark, N. J.
William F. Bornfleth, Cream City Foundry, Milwaukee.
A. E. Hageboeck, Frank Foundries Corp., Moline, Ill.
P. E. Rentschler, Hamilton Foundry & Machine Co., Hamilton, O.

FINANCE AND BUDGET COMMITTEE

Chairman—H. J. O'Neil, Western Foundry Co., Chicago.
H. S. Chafee, Builders Iron Foundry, Providence, R. I.
H. R. Lafferty, Red Jacket Mfg. Co., Davenport, Ia.
F. L. Squires, Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
H. C. Wilson, Cleveland Co-Operative Stove Co., Cleveland.

MERCHANDISING COMMITTEE

Chairman—Don McDaniel, Hamilton Foundry & Machine Co., Hamilton, O.
J. H. Bruce, Bowler Foundry Co., Cleveland.
H. R. Cooke, Olney Foundry Co., Philadelphia.
H. R. Martin, Detroit Gray Iron Foundry Co. Detroit.
R. R. Monroe, Des Moines Foundry & Machine Co., Des Moines, Ia.
H. S. Washburn, Plainville Casting Co., Plainville, Conn.

RESEARCH COMMITTEE

Chairman —B. H. Johnson, Cresson-Morris Co., Philadelphia.
Hyman Bornstein, Deere & Co., Moline, Ill.
J. D. Coltman, Bullard Machine Tool Co., Bridgeport, Conn.
E. J. Lowry, consulting metallurgist, Detroit.

STATISTICAL COMMITTEE

Chairman—K. L. Green, Green Foundry Co., St. Louis.
Harry Graham, Bond Engineering Works, Toronto, Can.
William J. Grede, The Liberty Foundry Inc., Wauwatosa, Wis.
W. F. McCarthy, McCarthy Foundry Co., Chicago.
Wallace E. Stephen, Roberts & Mander Stove Co., Philadelphia.

In addition to the committees mentioned a trade practice committee will be announced in the near future. The members of the various committees will be pleased to have suggestions as to the problems which should be undertaken by the committees.

Stanley M. Mercier recently has been appointed manager of the Boston office of the Jeffrey Mfg. Co., Columbus, O. The office is located at 141 Milk street, Boston.

Molds Enamel Ware on Continuous Units

(*Concluded from Page* 212)

revolving motion of the pebble mills grinds the frit into a fine enameled powder.

The powder is sifted through an exceedingly fine mesh screen, placed in containers made of sheet iron and is ready to be delivered to the enamelers. The slush or base coat previously referred to is mixed and melted in approximately the same manner as is enamel. It is placed in a mill similar to the one used for grinding enamel frit and with the addition of water and other ingredients in the mill, slush is produced in liquid form for direct application. This slush or base coat holds the enamel to the cast iron.

After the enameling process is complete, the ware is put in a cooling oven of brick construction which is large enough to hold only a single casting. When sufficiently cool to permit handling with gloves, the piece is taken from the cooling oven and delivered to the inspection department. When it has cooled completely, it is inspected and taken to the wareroom. It then is ready for the outside coat of paint. This is done with a spraying outfit operated with compressed air. When the paint is thoroughly dry, the piece is crated and is ready for shipment.

The Richmond Radiator Co. also makes coal fired boilers at its Norwich, Conn., plant and radiators and gas boilers at its Uniontown, Pa., plant. These plants are operated entirely apart from the enameled ware unit.

Meet in Dusseldorf

The annual general meeting of the Verein deutscher Eisenhuttenleute, the association of German ironmasters, will be held at Dusseldorf on May 4 and 5. On the morning of Saturday, May 4, the meeting will be opened with two group conferences, the first of which will discuss metallurgical questions, while the second will be devoted to questions relating to the further stages of manufacture. After a full program in the afternoon there will be a social meeting in the evening. The general meeting proper will be held on Sunday, May 5. In addition to business questions the agenda will include a paper by Prof. Dr. V. M. Goldschmidt, Oslo, on "The Natural History of the Iron Family," and an address by general director Dr. A. Vogler of Dortmund.

Completes Organization

Organization details of the new General Steel Castings Corp., that is building a new steel castings plant at Eddystone, Pa., just south of Philadelphia, have been completed. R. P. Lamont, president, American Steel Foundries, Chicago, is president of the General Steel Castings Corp. A. S. Blagden is vice president and general manager, with headquarters at Eddystone. Mr. Blagden was president of the Beaverboard Companies, with headquarters at Buffalo, until that company recently was taken over by the Certain-teed Products Corp. E. Walcher, manager, Granite City plant of the American Steel Foundries, has been made works manager of the General Steel Castings Corp. G. L. Alston has been appointed secretary and treasurer of the new company. Mr. Alston resigned as secretary of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., to become affiliated with the new company. Prior to his employment with the Birdsboro company, Mr. Alston was identified with the American Steel Foundries at Chicago.

The General Steel Castings Corp. is owned jointly by the American Steel Foundries, Baldwin Locomotive Works and American Locomotive Co., and is capitalized at $20,000,000. It will be devoted to casting locomotive beds and tender frames. The plant will comprise five buildings, each 100 x 1000 feet, and will have 500,000 square feet of floor space. David I s, chief engineer, American Ste Foundries, Chicago, is in charge of the engineering details at Eddystone. The plant is to be built by the American Bridge Co. Three basic open-hearth furnaces, each of 50-ton capacity, will comprise the melting equipment; two are to be built at once and the third later. Cranes, machinery and other equipment of the plant have not been purchased.

Sells Sand Machines

The Royer Foundry & Machine Co., Wilkes Barre, Pa., has sold sand separators and blenders to the Canadian Westinghouse Co. Ltd., Hamilton, Ont.; Covel Mfg. Co., Benton Harbor, Mich.; Consolidated Ashcroft Hancock Co., Bridgeport, Conn.; Ensign Foundry Co., Toledo, O.; Ferro Machine & Foundry Co., Cleveland; Perfect Circle Co., New Castle, Ind.; Frontier Iron Works, Buffalo; National Lock Co., Rockford, Ill.; and Wagner Mfg. Co., Sidney, O.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Dixie Foundry Co., Cleveland, Tenn., has plans under way for rebuilding its burned plant.

Reading Casting Co., Inc., has changed its address from Moncacy, Pa., to Birdsboro, Pa.

Dempsey Foundry Co., North Water avenue, Sharon, Pa., suffered damage by fire recently.

The Union Steel Casting Co., Pittsburgh, reports a net income for 1928 of $247,154.

American Steel Foundries, East St. Louis, Ill., plant has increased its production from a one to a two-furnace basis.

The Falk Corp., Milwaukee, is constructing a new 25-ton, open-hearth furnace designed by the Freyn Engineering Co., Chicago.

Latrobe Electric Steel Co., Latrobe, Pa., is considering a one-story addition which, including equipment, will cost about $60,000.

Superior Foundry, 3115 Main street, Dallas, Tex., Mr. Rinnessan manager, recently was damaged by fire.

Otis Elevator Co., Eleventh avenue and Twenty-sixth street, Quincy, Ill., plans the construction of a 1-story foundry addition.

Scott & Williams Inc., Laconia, N. H., will install power equipment in a proposed addition to the knitting machinery manufacturing plant.

Ford Motor Co., Dearborn, Mich., has let the structural steel contract for a foundry building to Whitehead & Kales Co.

Winton Engine Co., 2116 West 106th street, Cleveland, plans the construction of a 1-story pattern shop, 35 x 185 feet.

Extruded Metal Products Co., Wheeling, W. Va., Joseph Hillard, president, plans the construction of a new foundry.

Missouri Pattern Works, St. Louis, has been incorporated by F. W. Burgdorfer, 4600 Chippewa street, as president.

Eagle Foundry Co., St. Louis, has leased a site in East St. Louis, where it will move its assembly plant.

Van Loon Pattern Works, Anderson, Ind., plans the construction of a manufacturing plant, 50 x 150 feet at 1670 Ohio avenue.

Caterpillar Tractor Co., East Peoria, Ill., M. M. Baker manager, has awarded the general contract for the construction of a 2-story foundry to Austin Co., 510 North Dearborn street.

Queen City Semi-Steel Foundry Co., Newport, Ky., has been incorporated with $10,000 capital by J. Arthur Leary and Louis B. Arnold.

General Steel Castings Co., Eddystone, Pa., has let a contract for structural steel for its new foundry to the American Bridge Co.

Aluminum Co. of America has removed its office from 1228 Third National building, Dayton, O., to 910 Dixie Terminal building, Cincinnati.

Center Foundry & Machine Co., Wheeling, W. Va., has elected the following directors for the year: C. A. Vaden, M. E. Young, A. C. Hugus, and J. H. Young.

Sacks-Barlow Co. Inc., 357 Wilson avenue, Newark, N. J., has awarded the general contract for a one-story foundry to Enstice Bros., 111 Academy street, Newark.

Southern Signal Co., 2017-19 Portland avenue, Louisville, Ky., is planning to rebuild the portion of its plant destroyed by fire recently. (Noted Feb. 15.)

Tait Pipe & Foundry Co., Vancouver, B. C., is making changes and additions to its plant including the installation of a monorail system.

General Steel Wares Ltd. has taken over the equipment branch of Fletcher & McLaughlin Ltd., Toronto, Ont., manufacturer of Soda fountains.

Portland, Forge & Foundry works, Portland, Ind., was damaged by fire recently. Some machinery and motors were saved. Repairs will be made immediately.

Pyle Pattern & Mfg. Corp., Muskegon Heights, Mich., has awarded the contract for the construction of a 2-story plant, 50 x 125 feet, to George Lather & Sons.

Marine City Motor Castings Co., Marine City, Mich., has filed a voluntary petition for bankruptcy. The Central Trust Co., Detroit, has been appointed receiver.

Ashland Ornamental Iron Works, 7018 South Ashland avenue, Chicago, has been incorporated to engage in a general foundry and machine shop business by Edwin E. Olson.

Alloy Cast Steel Co., Marion, O., has awarded the general contract for extensions and improvements to its plant, including an additional melting unit. (Noted Feb. 15.)

Milwaukee Automotive Trades Inc., Milwaukee, has installed a cupola at its salvage yard and is producing sashweights. Preparations are being made to cast elevator weights and other products.

Williams, White & Co., Moline, Ill., recently opened its new foundry with a housewarming. Special invitations were extended to the Quad-City Foundrymen's association and other technical organizations.

Johnson City Foundry & Machine Works, Elizabethton, Tenn., has acquired the plant and equipment of the Watauga Extract plant. It is now moving the plant to the Johnson City works plant.

Crucible Steel Casting Co., 1330 Fifteenth avenue, Milwaukee, has placed the contract with the Raulf Co., 428 Wisconsin avenue, for a one-story shop addition, 40 x 122 feet. Albert T. Lange is president and general manager.

Modern Machine Co. Ltd., Ottawa, Ont., has been incorporated to carry on a general foundry and machine shop business, with $300,000 capital by Alfred E. Adams, Harry Bramah, Cecil B. Channon and others, all of Toronto.

Rundle Mfg. Co., Twenty-seventh street and Cleveland avenue, Milwaukee, is inquiring for electric bridge cranes, conveying equipment, etc., for its proposed foundry and enameling building being built at Camden, N. J.

National Foundry Co. of New York, 10 Sandford street, Brooklyn, N. Y., has engaged Laspia & Samenfeld, 269 Broadway, New York, as architects for the construction of a foundry, 60 x 218 feet. (Noted Feb. 1.)

West Virginia Malleable Iron Co., Point Pleasant, W. Va., has elected M. L. Byers president, C. R. McCulloch general manager, Gordon Jackson secretary-treasurer, and George Hokanson general superintendent.

Fitzgibbons Boiler Co., Oswego, N. Y., has been granted a permit for the construction of a railroad siding from the New York Central railroad to its new foundry between East Ninth and East Tenth streets.

Star Foundry, Seattle, has leased a site at Horton street and Third avenue south from the Port of Seattle for a term of 30 years. The company is planning to move its plant from Youngstown to the new site.

Glamorgan Pipe & Foundry Co., Lynchburg, Va., has reelected its officers as follows: H. L. Campbell, president; W. R. Winfree, vice president; J. C. Dabney, vice president; F. K. McVeigh, secretary and treasurer.

American Radiator Corp. has amended its incorporation certificate in Delaware, changing the corporate name to American Radiator & Standard Sanitary Corp., to provide for merger with the Standard Sanitary Corp., Pittsburgh. (Noted Jan. 15).

D. A. Ebinger Sanitary Mfg. Co., 401 West Town street, Columbus, O., is pushing work toward completion on its new plant addition. Elford & Son are contractors for the construction. The Ebinger company facilities include a complete gray iron foundry and porcelain enameling plant. (Noted Jan. 15).

Northfield Foundry & Machine Co., Northfield, Minn., reports that the company enjoyed good business during the past year. The following men are officers of the company: Mike Machacek, president, George Machacek, vice president; Oliver Machacek, treasurer and Elsner Machacek, secretary.

General Welder Co., 95 Steiner avenue, Akron, O., incorporated recently with $100,000 capital, has a fully equipped machine shop, pattern works, bronze, copper and gray iron foundries in connection with its plant. It will manufacture special welding machines, and contemplates the manufacture of standard machines.

Precision Machinery & Foundry Ltd., Calgary, Alta., has been incorporated to carry on the business as iron founder, mechanical engineer and manufacturer of machinery, tools, etc., with $250,000 capital by Percy L. Standford, Alexander Hannah, Edward J. Chambers, all of Calgary .

The foundry department of the Studebaker Corp., South Bend, Ind., has received an appropriation of several hundred thousand dollars. The money will be used for the purchase of machinery needed in an expansion program which calls for an increase in gray iron production.

The hoist business of the Electric Steel Foundry, Twenty-fourth and York streets, Portland, Ore., has been consolidated with the lumber and hoist business of the Willamette Iron & Steel Works and the Ersted Mfg. Co., both of Portland. The new company will be known as the Willamette-Ersted Co., and all manufacturing of the new company will be handled at the Ersted plant, 918 Clackmas street.

Scott Valve Mfg. Co., Detroit, has been reorganized and facilities for manufacture of valves have been enlarged. The officers are: Alexander P. Gow, president; John A. Baas, vice president; A. DeLong Thomas, secretary; and Guy C. Powell, treasurer. Directors are W. F. Austin, John A. Baas, Alexander P. Gow, Guy C. Powell, A. DeLong Thomas and E. W. Thomas.

Dunkirk Radiator Corp., now constructing a large plant in Dunkirk, N. Y., has acquired control of the Lincoln Radiator Corp. at Utica, N. Y., and will use it for the exclusive manufacture of radiators, while Dunkirk production will include boilers. The Utica plant will go into operation about March 1. Earl C. Reed is president of both companies. William C. Murray, vice president and treasurer of the Dunkirk company, will manage the Utica plant.

J. B. Klein Iron & Foundry Co., Oklahoma City, Okla., is planning to erect several buildings including a gray iron and nonferrous foundry, 70 x 100 feet. The company will move from its present location at 1004 West Second street to the new plant at Fourth and Blackwelder streets as soon as the first unit is completed. R. W. Robertson is president; C. A. Lord, engineer; William Klein, superintendent; C. L. Bullock, assistant superintendent. (Noted Feb. 15.)

Galesburg Malleable Castings Co., Galesburg, Ill., has been taken over by the American Steel Foundries and will be known as the Galesburg plant of the American Steel Foundries. This company was organized in 1907 by Dyke Williams and F. B. Stone. The plant was sold to the American Steel Foundries in Dec. 1920 but continued to operate as the Galesburg Malleable Castings Co. R. H. Ripley, vice president of the company also is second vice president of the American Steel Foundries. C. H. Bossong is works manager.

New Trade Publications

WELDING RODS—Chicago Steel & Wire Co., Chicago, in a current bulletin describes its line of welding rods for various purposes.

ELECTRIC SWITCHES—American Electric Switch Corp., Minerva, O., has issued a catalog of its line of safety switches, meter switches and fuse panels.

ALLOY STEEL—American Manganese Steel Co., Chicago, illustrates in a current bulletin the advantages of steel parts made from its alloy steel, designed for service under trying conditions of stress. Halftones and test data cover many applications.

ENGINEERING SUPPLIES—Marion Machine, Foundry & Supply Co., Marion, Ind., is distributing two bulletins. One illustrates various devices for engineering work, power devices, walking beams, toolhouses, clamps, stuffing boxes and samson posts. The other covers its tubular steel derrick, with illustrations and engineering data.

CAST IRON PIPE—Herbert Kennedy Co., New York, importer of cast iron pipe, is circulating a booklet by Societe Pont-a-Mousson, Nancy, France, manufacturer of cast iron pipe. It discusses cast pipe and illustrates the method of manufacture and other features. Tables of weights and drawings of sections are given.

FOUNDRY MIXTURES—A bulletin by the International Nickel Co., New York, presents a dozen practical foundry mixtures for various classes of castings. Use of nickel as an alloy is a feature of these mixtures.

FOUNDRY SUPPLIES—The Goehringer Foundry Supply Co., 919-21 West Fifth street, Cincinnati, recently has issued several folders on foundry supplies. They deal with the advantages and uses of binders and cements that the company handles.

MOLDING MACHINES—The universal System of Machine Molding & Machinery Co. Ltd., 13/15 Wilson street, London, E. C. 2, is circulating a folder on its new compressed air or hydraulically operated molding machine. The advantages, specifications, and principal dimensions are discussed. The folder also contains an illustration of the machine.

TESTING—Wagner Electric Co., St. Louis, recently issued a bulletin on electrical testing. The bulletin contains descriptions of the various methods used to test various types of motors. Diagrams illustrate the methods used.

OVENS—General Electric Co., Schenectady, N. Y., recently circulated a folder on its heating equipment for industrial ovens. Heating units and oven control are discussed and illustrated. It also contains several illustrations of typical installations.

PUMPS—Pennsylvania Pump & Compressor Co., Easton, Pa., is circulating a folder describing its new pump for use in draining excavations, trenches, subways, etc. It is a light, portable pump with 3-inch discharge and 4-inch suction openings. Its maximum capacity is 350 gallons per minute.

BUCKETS—Blaw-Knox Co., Pittsburgh recently has issued a bulletin on its ball-bearing buckets. The new feature of these buckets is the use of ball-bearings in the sheaves. The bulletin illustrates and describes the various types of buckets made by this company and points out the advantages and details of construction and uses. It also gives the points to be considered in the selection of such apparatus. The bulletin contains a chart giving specifications of the various types of buckets that the company manufactures.

SAND CONTROL APPARATUS—Harry W. Dietert, Box 1506, Detroit recently has issued several folders illustrating and describing pieces of sand control apparatus. These folders give data on the Grubb moisture tester, tensile strength corebox, sand testing machine, and rammer.

ALLOY STEEL CASTINGS—Alloy Cast Steel Co., Marion, O., has published a bulletin on the subject of alloy steel castings, showing their application to various classes of machinery requiring strength and resistance to wear and breakage.

SANDBLAST NOZZLES—Direct Separator Co., Syracuse, N. Y., recently has published a 12-page booklet giving information on its sandblast nozzles. The booklet contains illustrations of the various nozzles both assembled and disassembled. It also gives tables showing operation data, a partial list of users and illustrations and specifications of both vertical and horizontal divide air separators.

HARDNESS TESTERS—Wilson-Maeulen Co., 383 Concord avenue, New York, has issued a catalog on its Rockwell hardness tester. The booklet describes and illustrates the machine in detail and gives some of its uses. A list of prices and spare parts and a list of some of the users of this equipment both in the United States and abroad also is given.

GAS PUMPS—The P. H. & F. M. Roots Co., Connersville, Ind., in a current bulletin outlines the various types of pumps and explains the nomenclature and operating principles of the rotary gas pumps which it makes. The booklet also gives tabulated data on pressures, capacities and horsepowers and includes a detail drawing of a typical unit. The catalog contains several illustrations from photographs of typical installations.

AIR COMPRESSORS—Pennsylvania Pump & Compressor Co., Easton, Pa., recently has issued a bulletin on its direct connected electric motor driven and belt driven duplex air compressors. The bulletin shows cross sections of the machine and of many of the parts. It describes the details of the machine and explains the function of each. It also contains several illustrations from photographs of typical installations.

ALUMINUM AND ITS ALLOYS—Recently the Vereingte Aluminum-Werke A. G., Lautawerk, Germany, published a 31-page bulletin describing the use of aluminum and aluminum alloys in the electrical industry. Uses include rolled and drawn materials such as wire, bars, and aluminum clad steel wire for transmission lines. Cast alloys such as rotors and supporting arms for brush holders also are described. Cast parts of other apparatus and instruments are included.